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2011 MEMORY BUYER'S GUIDE

FREE Liquid Cooling on all systems

Gamer Infinity 8800 Pro SE

Intel® Core™ i7 Processor

Genuine Microsoft™ Windows® 7 Home Premium 64-bit Edition Service Pack 1

Gigabyte® GA-Z68-A D3-B3 Mainboard w/ USB 3.0 and SATA III

Corsair® 12GB DDR3 1333 Triple Channel Memory

Kingston 30GB SSD(Boot) + 2TB SATA III DATA HDD

Nvidia® Geforce® GTX 570 1.2GB Direct X 11 Video

AZZA Hurrican 2000 Full Tower Case 800 Watt Power

Asetek Liquid Cooling System

Nvidia® 3D Vision Glass and LCD + $499

Intel® Core™ i7 Processor

i7	(8MB L3 Cache, 1066Mhz)		From
	Extreme i7-990X 3.33Ghz	$ 2249	**$1455**
	i7-980 3.33Ghz	$ 1775	
	i7-960 3.20Ghz	$ 1469	
	i7-950 3.06Ghz	$ 1455	

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Gamer Xtreme XT

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Gigabyte® GA-Z68-A D3-B3 Mainboard w/ USB 3.0 and SATA III

Corsair® 6GB DDR3 1333 Triple Channel Memory

2TB SATA-III 6.0 7200 RPM HD 64MB Cache

Nvidia® GeForce® GTX 560 1GB Direct X 11 Video Card

Inwin Dragon Rider Full Tower Case with 600 Watt Power

Asetek Liquid Cooling System

Intel® Core™ i7 Processor

i7	(8MB L3 Cache, 1066Mhz)	
	Extreme i7-990X 3.33Ghz	$ 1869
	i7-980 3.33Ghz	$ 1389
	i7-960 3.20Ghz	$ 1079
	i7-950 3.06Ghz	$ 1075

From **$1075**

Gamer Xtreme 1000
Intel® Core™ i7 Processor

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Corsair® 4GB DDR3 1333 Dual Channel Memory

1TB SATA-II 3.0 7200 RPM HD 16MB Cache

Nvidia® GeForce® GTX 550Ti 1GB Video Card

Raidmax Blade Gaming Case 600 Watt

Asetek Liquid Cooling System

Intel® Core™ i7 Processor

	(8MB L3 Cache, 1066Mhz)		
i7	i7-2600K 3.40hz	$869	
	i7-2600 3.40Ghz	$845	
i5	i5-2500K 3.30Ghz	$759	**From**
	i5-2500 3.30Ghz	$749	**$615**
	i5-2400 3.10Ghz	$735	
	i5-2300 2.80Ghz	$719	
i3	i3-2100 3.10Ghz	$615	

Gamer Xtreme 2000
Intel® Core™ i7 Processor

Genuine Microsoft™ Windows® 7 Home Premium 64-bit Edition Service Pack 1

Gigabyte® GA-Z68-A D3-B3 Mainboard w/ USB 3.0 and SATA III

Corsair® 8GB DDR3 1333 Dual Channel Memory

1TB 7200RPM SATA-II 3.0Gb/s 16MB Cache Ultra Fast HD

ATI Radeon® HD 6770 1GB Video Card
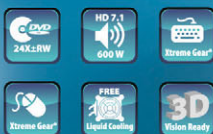
Apevia X-Dreamer 3 Gaming Case with 600 Watt CrossFire Power

Asetek Liquid Cooling System

Intel® Core™ i7 Processor

	(8MB L3 Cache, 1066Mhz)		
i7	i7-2600K 3.4hz	$999	
	i7-2600 3.4Ghz	$979	
i5	i5-2500K 3.30Ghz	$895	**From**
	i5-2500 3.30Ghz	$885	**$769**
	i5-2400 3.10Ghz	$865	
	i5-2300 2.80Ghz	$855	
i3	i3-2100 3.10Ghz	$769	

Gamer Xtreme 3000
Intel® Core™ i7 Processor

Genuine Microsoft™ Windows® 7 Home Premium 64-bit Edition Service Pack 1

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2TB S ATA-III 6.0 7200 RPM HD 64MB Cache

Nvidia® Geforce® GTX 560 1GB Direct X 11 Video

CoolerMaster HAF 912 Gaming Tower Case with 700 Watt Power

Asetek Liquid Cooling System

Intel® Core™ i7 Processor

	(8MB L3 Cache, 1066Mhz)		
i7	i7-2600K 3.4hz	$1115	
	i7-2600 3.4Ghz	$1089	
i5	i5-2500K 3.30Ghz	$1005	**From**
	i5-2500 3.30Ghz	$995	**$879**
	i5-2400 3.10Ghz	$975	
	i5-2300 2.80Ghz	$965	
i3	i3-2100 3.10Ghz	$879	

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Intel® HM67 Chipset
802.11 B/G/N Wireless Network

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1x HDMI
1x IEEE 1394
3x USB 3.0
3 hr
5.9 Lbs

8GB DDR3 PC1333 Memory
500GB SATA150 Hard Drive
15.6" Full HD 1920 X 1080
Nvidia® Geforce® 540M 2GB Direct X 11 Video Card
1000/100/10 Network Card
Free Carrying Case

8X±RW
7 in 1 Media Reader
Built-in

Intel® Core™ i7 Processor

i7	2920XM	$1759	
	2820QM	$1219	**From $769**
	2630QM	$859	
i5	2410M	$819	
i3	2310M	$769	

Gamer Xplorer X6-9300
Intel® Core™ i7 2630QM Processor

Intel® HM65 Chipset
802.11 B/G/N Wireless Network

Genuine Microsoft™ Windows® 7 Home Premium 64-bit Edition Service Pack 1

1x HDMI
1x IEEE 1394
3x USB 3.0
3 hr
5.9 Lbs

8GB DDR3 PC1333 Memory
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15.6" Full HD 1920 X 1080
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1000/100/10 Network Card
Free Carrying Case

8X±RW
7 in 1 Media Card
Built-in

Intel® Core™ i7 Processor

i7	2920XM	$2159	
	2820QM	$1619	**$1259**
	2720QM	$1419	
	2630QM	$1259	

intel inside™
CORE™ i7
Visibly Smart

Cyber POWER Inc.

SPOTLIGHT

Featured On The Cover

Frontside

Heavy Gear

Hard Hat Area

THE CHOICE OF CHAMPIONS

REPUBLIC OF GAMERS

Crosshair V Formula
- AMD AM3 & AM3+ "Bulldozer" processors
- AMD 990FX chipset with multi-GPU support [including 3-way SLI™]
- Thunderbolt LAN/Audio add-on card*
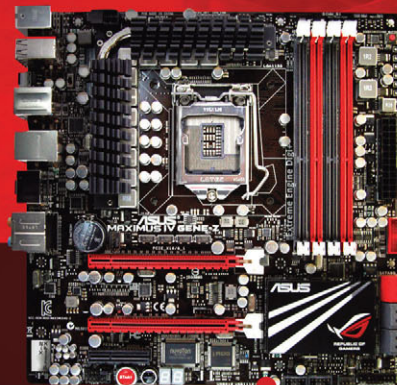
Maximus IV Gene-Z
- Intel® LGA 1155 socket
- Intel® Z68 chipset
- Lucid® Virtu™ switchable graphics
- mATX form factor

Maximus IV Extreme-Z
- Intel® LGA 1155 socket
- Intel® Z68 chipset
- Lucid® Virtu™ switchable graphics
- 3-Way SLI™ support

No matter how you want to get to the top in gaming or overclocking, ASUS Republic of Gamers (ROG) series motherboards are the choice of champions everywhere. Each motherboard is feature packed for superior performance and maximum pwnage in any battlefield anytime, anywhere.

ROG MOTHERBOARD FEATURES:

Multi-GPU Support
Whether its NVIDIA® SLI™ or AMD CrossfireX™, ROG series motherboards support multi-GPU for uncompromised graphics and performance.

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When push comes to shove, connect the motherboard via USB to another computer for real time reporting and overclocking without quitting game play.

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92

THE WITCHER 2
ASSASSINS OF KINGS

Gotcha.
Here it is.

Samson Debuts Multi Mic-Bearing Zoom H2n

Where handheld, in-the-field audio recording is concerned, Samson Technologies' new Zoom H2n ($199) offers some fairly compelling features, none the least being the inclusion of five microphone capsules that make possible Mid-Side stereo, 90-degree X/Y stereo, and 2-channel and 4-channel surround-sound recording. As for the Mid-Side option, Samson states the Zoom H2n is the first handheld recorder to offer the feature, a staple in film and broadcast recording that captures sound emitting directly in front of the recorder via unidirectional mic and sound to the left and right via a bi-directional mic. Usage-wise, the Zoom H2n sports a 1.8-inch backlit LCD; reference speaker; line-in, line-out, and headphone inputs; USB port; SD/SDHC card slot; mic gain wheel, and jog dial/transport mechanism. A free copy of Steinberg's WaveLab LE 7, meanwhile, provides editing and mastering ability. ∎

SanDisk Vows To Resuscitate Aging Systems

What power user doesn't have a system or two that's long in the tooth but still operational? If this describes you, SanDisk wants to help "extend the life" of your tired desktop or notebook with its new Ultra SSD, a SATA 2.0, MLC NAND flash-based SSD it states is a "convenient drop-in solution for technology enthusiasts looking to upgrade their own PCs for an enhanced user experience." In fact, Kent Perry, director of product marketing, goes so far as to say replacing a computer HDD with the Ultra is "more cost-effective than buying a new PC." Available in 60GB ($129.99), 120GB ($219.99), and 240GB ($449.99) models, the Ultra boots up or shuts down 2X as quickly as a 7,200rpm drive, SanDisk touts, and carries a 1 million-hour MTBF rating and 280MBps/270MBps read/write rated speeds. ∎
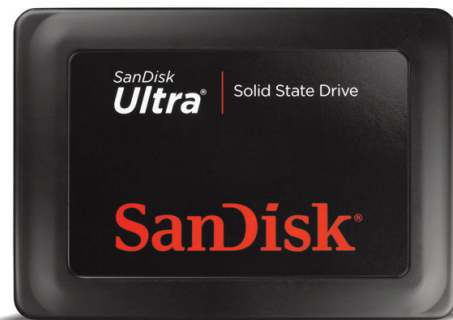
WATCHING THE CHIPS FALL

Here is the pricing information for various AMD and Intel CPUs.

CPU	Released	Original Price	Company Pricing*	Online Retail Price*
AMD Phenom II X6 1100T Black Edition	12/7/2010	$265**	$205**	$189.99
AMD Phenom II X6 1090T Black Edition	4/27/2010	$295**	$185**	$179.99
AMD Phenom II X6 1075T	9/21/2010	$245**	$181**	$169.99
AMD Phenom II X6 1055T	4/27/2010	$199**	$165**	$159.99
AMD Phenom II X4 980 Black Edition	5/3/2011	$185	$185**	$189.99
AMD Phenom II X4 975 Black Edition	1/4/2011	$195**	$175**	$179.99
AMD Phenom II X4 970 Black Edition	9/21/2010	$180**	$155**	$149.99
AMD Phenom II X2 560 Black Edition	9/21/2010	$105**	$90**	$91.99
AMD Athlon II X4 Quad-Core 645	9/21/2010	$122**	$102**	$106.99
AMD Athlon II X3 Triple-Core 460	5/3/2011	$87**	$87**	$92.99
Intel Core i7-990X Extreme Edition	2/14/2011	$999**	$999**	$999.99
Intel Core i7-2600K	1/9/2011	$317**	$317**	$314.99
Intel Core i7-2600	1/9/2011	$294**	$294**	$299.99
Intel Core i5-2500K	1/9/2011	$216**	$216**	$219.99
Intel Core i5-2500	1/9/2011	$205**	$205**	$209.99
Intel Core i5-2400	1/9/2011	$184**	$184**	$194.99
Intel Core i5-2310	5/22/2011	$177**	$177**	$189.99
Intel Core i3-2120	2/20/2011	$138**	$138**	$149.99
Intel Core i3-2105	5/22/2011	$134**	$134**	$139.99
Intel Core i3-2100	2/20/2011	$117**	$117**	$124.99

* As of July 2011

** Manufacturer's estimated price per 1,000

Paging Dr. Kinect, Please Report To The OR

There's seemingly nothing Microsoft's Kinect can't do. Take, for example, recent reports that surgeons at Sunnybrook Health Sciences Center in Toronto are using the Kinect's motion-sensing abilities during surgeries to access real-time CT scan data. Previously, this required using a computer and mouse located outside the OR, which meant surgeons leaving the sterile OR had to re-scrub upon each re-entry. With Kinect in tow, surgeons instead use gestures to navigate and view the scans in the OR. Surgeon Dr. Calvin Law stated the approach means "we're able to bring that computer, as if it was the last member of our team, into the working field of the operating room." As PopSci.com reported, previously, University of Washington engineering students hacked the Kinect to add force feedback to robotic equipment used in procedures in which human hands are too big to do so. Compared to the Kinect, a similar system designed to do the same reportedly ran roughly $50,000. ■

Don't Own A Web-Connected TV? You Will Soon

By year's end, global sales of connected televisions will top gaming consoles for the first time, states Informa Telecoms & Media. Console makers will sell 37 million units this year vs. the 52 million connected TVs consumers will purchase, states the forecaster. By 2016, 1.8 billion in-home video devices (tablets, game consoles, connected TVs, etc.) are expected to sell, which is about an 800% increase from today, with 70% being Internet-connected. Analyst Andrew Ladbrook stated "until now, many online video services were launched primarily with the game console in mind, mainly because console users innately understand how to connect these devices and demand interactive video services from them." This is changing, Ladbrook says, "as connected TVs bring these services to a mainstream audience." Display-Search, meanwhile, forecasts that by 2015 more than 500 million connected TVs will ship. In 2011, more than 25% of all flat-panel TVs shipping will be Internet-connected, DisplaySearch stated. By 2015, that total will jump to 47% (138 million units). ■

Hardware Mole

"Better Watch Out, Dastardly Pigs"

So warns Roku in marketing material on its Web site promoting the company's new Roku 2 lineup of video-streaming players—three models all integrating Bluetooth and microSD and offering 1080p quality and Dolby Digital Plus 5.1 pass through support for Netflix. The XS ($99.99; 1080p, USB, and Ethernet ports) model additionally ships with a free full version of Angry Birds. Why? Because the XS also includes a Bluetooth-enabled game remote with integrated accelerometer and gyro for "casual gaming." Overall, Roku states all the models are the smallest streaming video players ever and use less than 2 watts of energy while streaming flicks, 20X less than a DVR and 80X less than when streaming a movie on a "popular game console." The lineup's other models—HD ($59.99; 720p) and XD ($79.99; 1080p)—don't include the remote, which sells separately with a 2GB microSD card bundled for $29.99. ■

Grad Student Goes Big Time With "Star Wars" RTS

If you like your "Star Wars"-related goodies in gigantic portions, step on up to Fleet Commander, an RTS title Arthur Nishimoto, University of Illinois at Chicago's Electronic Visualization Laboratory grad student, developed that's playable on EVL's 20-foot LCD screen. Reportedly, the multiplayer title, which Nishimoto started in 2009, initially played on a 52-inch TacTile multitouch display, but Nishimoto recently ported it to EVL's much larger, 8,160 x 2,304 LCD touch-based wall. The game and wall's vastness reportedly supports as many players who can stuff themselves into the 20-foot space for controlling "cruisers, destroyers, corvettes, fighters, bombers, and mighty superweapons to win the battle." On his Web site, Nishimoto states, "In terms of inspiration for the 'Star Wars' theme, I primarily used Lucasarts' Star Wars: Rebellion (1998) for the basic gameplay mechanics, as well as the Rebel red/Imperial green color schemes. Star Wars: Empire at War (2006) also plays a role as being Lucasarts's latest space strategy game." ■

Tango Does The Desktop PC Dance

As startups go, Tango is doing quite well, thank you. The company, which offers a free platform-crossing video and calling service via mobile device apps, reportedly registered more than 18 million users in 190 countries as of early July, roughly 10 months after the 3G/4G/Wi-Fi-supporting service launched. That number should only increase now that Tango has announced plans to release a desktop PC version of the software. In a press release touting the PC plans, Tango CEO Uri Raz stated that the launch positions the company "to reach our goal of 100 million customers by this time next year." Registering for Tango's service only requires supplying a mobile phone number, and the software works identically whether running on a mobile device or PC. ∎

South Korea Gets Smart On Education

Among the numerous trailblazing maneuvers that South Korea's Education Ministry recently announced as part of the country's "Smart Education" plan is a move toward hosting digital copies of required reading and lessons for school-age students on a cloud network that students could access from any Internet-connected device. In fact, by 2015, South Korea plans to spend $2.4 billion to fund measures that will enable it to completely do away with traditional print textbooks in favor of digital copies for all students to access via tablets, smartphones, and other devices. Reportedly, the cloud network-device approach will mean that students who are unable to attend school due to illness or poor weather would still have the means to participate in classroom activities and access lessons remotely. ∎

Linux Jumps To Version 3.0

This is a big year for Linux, as it marks the 20th anniversary of the open-source OS. The Linux Foundation planned to commemorate the event at this year's LinuxCon in Vancouver. The foundation is also awarding five Linux Training Scholarships this summer to invest in "today's most promising Linux talent." Linux.com, meanwhile, is taking submissions for an exclusive series that it is producing to present "some of the most interesting Linux stories from the last 20 years." As for the actual operating system, Linus Torvalds announced the official release of Linux 3.0 in mid-July. The 3.0 version signifies the end of the Linux 2.6 kernel run but, despite the jump to 3.0 (made to commemorate the anniversary), it amounted to being mostly unspectacular in terms of major new features added. ∎

Software Shorts
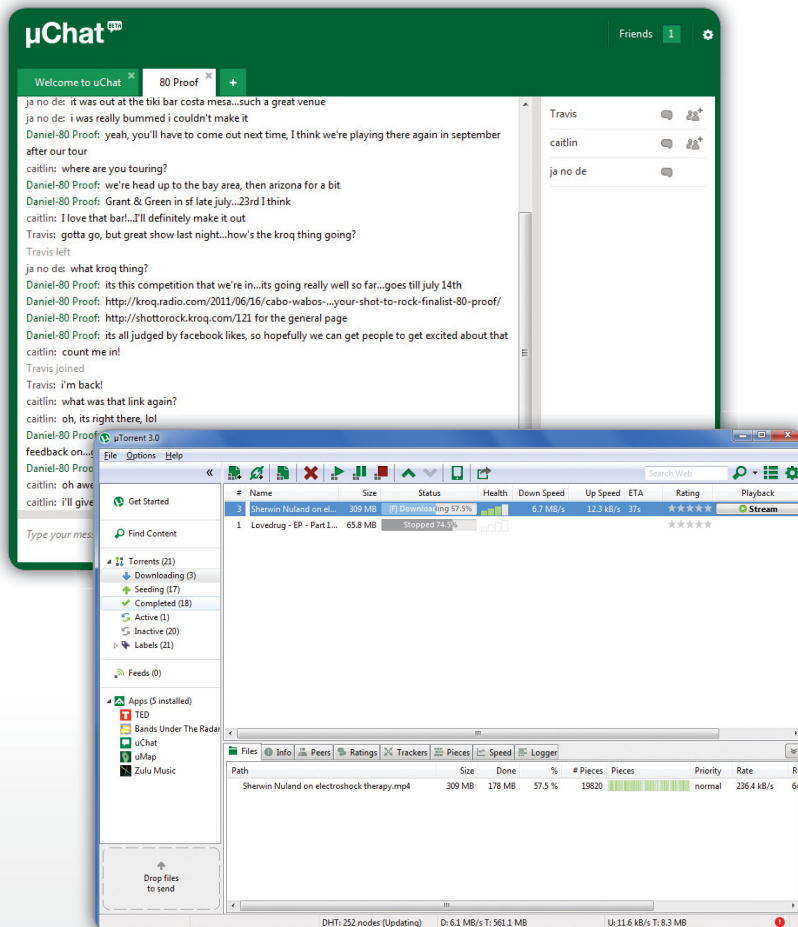
uTorrent Enters The Land Of Paid

Roughly a month after releasing version 3.0 of its free uTorrent client, BitTorrent announced via blog post that it's working on a paid version of uTorrent called Plus that it is "taking reservations" for via invite-only betas at www.utorrent.com /community/labs/plus. Though Jordy Berson, director of product management, wrote that BitTorrent isn't ready to release all details concerning Plus, the version is "designed for people who are looking for a single solution to find, get, and play content anywhere on any device." He added that codec and conversion hassles, device shifting struggles, and more "will be a thing of the past." As for the free uTorrent version, it will continue to "receive the same level of commitment and development resources as it does now." In conjunction with the 3.0 release, BitTorrent also released a new uChat app as a "way to make and keep relationships with people around the world with no central server" required. ∎

RealDownloader Makes Video Downloads A Breeze

One click. That's how easy Real-Networks' recently released Real-Downloader (free) utility makes downloading Web videos from supported sites. A Plus version ($29.99) adds the ability to transfer videos to various video-playing devices, bump download speeds by up to 200%, and more. RealNetworks claims the free version works with thousands of Web sites; can download multiple videos at once; supports Internet Explorer, Firefox, and Chrome; enables sharing via Facebook, Twitter, and email; supports offline viewing; and supplies a "light video viewer" for files not compatible with a given media player you have installed. Downloading a video is as easy as hovering the mouse pointer over the video's upper-right corner and using the drop-down menu that appears. ∎
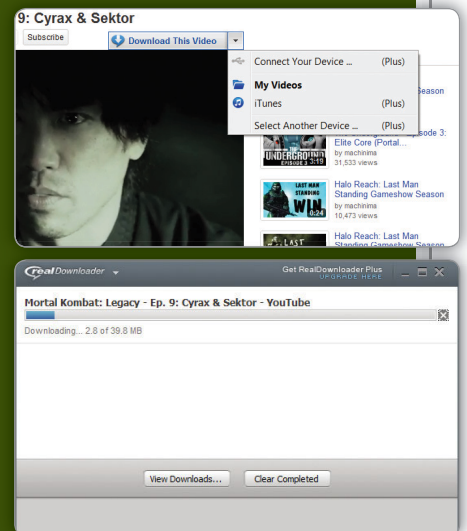
Google Toolbar For Firefox No More

"For Firefox users, many features that were once offered by Google Toolbar for Firefox are now already built right into the browser. Therefore, while Google Toolbar for Firefox works on versions up to and including Firefox 4 only, it will not be supported on Firefox 5 and future versions." With those words posted on Google's Toolbar Help page July 19, Google did Firefox users wrong, at least according to comments numerous Firefox faithful left on the page, including some citing Google's self-interest and promotion of Chrome as the cause. Introduced in 2005, the Google Toolbar For Firefox tool enables syncing bookmarks to a Google account, among other functions. Via the Google Toolbar Help site, Google does offer suggestions to add-ons offering "similar functionality" to the toolbar. Reportedly, roughly a third of Firefox users are still using Firefox 3.6 due to version 5's missing support for the toolbar. ■

The Mobile Migration To Maps

Need another indicator that users are increasingly turning to smartphones for Internet access in favor of doing so on desktop PCs? Look no further than maps. According to a U.S. study that comScore conducted over a three-month period ending in May, 48 million mobile users viewed maps on mobile devices during the period, up 39% from 2010. Those accessing maps from a home or work PC, however, dipped 2% to 93.8 million. Map usage by way of apps was "the primary access point for smartphone owners," comScore stated, with about two-thirds of map users using apps (up 98%). Elsewhere, comScore stated that "browser map access was about half as popular as apps and grew at half the rate." ■

Cuba Making Progress—Sort Of

Numbers that Cuba's National Statistics Office recently released indicate that the communist-controlled country is slowly catching up to the rest of the world where Internet connectivity is concerned, though the country still has a long way to go. Positively, the office reported there were 1 million mobile phones operating by 2010's end vs. 621,000 in 2009 and 330,000 in 2008. Conversely, activating a mobile phone reportedly costs $30, which tops the $24 average monthly salary for the nation's residents. Elsewhere, roughly 1.8 million of the country's 11.2 million citizens have access to some Internet service (email, Cuba's Intranet, or Web access) via about 64 computers per 1,000 residents in place. Most citizens, however, can only connect using Cuba's government-run Intranet functioning mostly via phone lines, as broadband connectivity is absent. An undersea fiber-optic cable running from Venezuela, however, is expected to bring better access to Cuba. ■

Site Seeing

DearPhotograph.com Oozes Sentimentality

Here's the premise of the nostalgia-drenched DearPhotograph.com: "Take a picture of a picture from the past in the present." Confused? Head to the site and you won't be. Essentially, users submit present-day photos framing a past photo taken in the same setting. Reportedly, 20-something Canadian Taylor Jones got the idea for DearPhotograph.com while viewing an old family photograph while sitting in the same kitchen the photograph was shot in. The site's sentimental nature really gushes in the reflections that children and grandchildren express in captions accompanying the modern photos they submit of parents or grandparents shown in the same location as the present-day photo and conversely from parents commenting on past photos of now-grown children. Although the site's archive only dates back to May, in many ways DearPhotograph.com exudes a sense of indescribable timelessness. ■
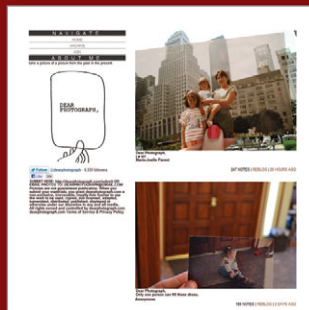
Earbits' Unconventional Approach To Streaming Radio

We have a soft spot in our hearts for any CEO who sports dreadlocks like the ones Joey Flores dons in the CEO bio photo on Earbits.com, described as a free "personalized streaming" online radio service that features unlimited skips and no ads, commercials, or subscriptions. Instead, the site's "team of self-proclaimed experts" hand-pick the music that plays on the site from artists who essentially pay for the ability to expose their music, merchandise, concert dates, and more to listeners. Current artists include such known acts as Weezer, KRS-One, Alkaline Trio, and Grammy-winners Arrested Development but mostly bands you probably don't know but Earbits believes you should. Stations, which you can play from a browser-embedded player, include the standard variety but also Listener's and Editor's Picks. Online interaction with bands is also available via Facebook and Twitter. ■

Job Of The Month

Want to work at one of the most revered game design studios of all time, but figure you need a decade of technical expertise before you sign on to a team that already has Wolfenstein, Doom, and Quake under its belt? Actually, at id Software there is room for younger talent, providing you have some experience. A recent job listing for a Level Designer asks for two-plus years of game industry design experience and a "firm understanding of first-person action shooters and the game theory and design principles behind successful examples." Experience with game engines is also important, and knowing id's own game portfolio is helpful. Also, and you need to have been significantly involved in a AAA title already and be proficient in modeling tools such as Maya, LightWave, etc. Oh, and you should have multiplayer game design chops. So this isn't exactly for entry-level applicants, but how cool would it be to work for the studio that will be releasing its next great FPS, Rage, in early October?

bit.ly/onDKR9

RAW Numbers

15%
Percent of Facebook users who update their own status on an average day
(Pew Internet & American Life Project)

158.1 MILLION
Number of U.S. Internet users who view online video
(eMarketer)

32%
Percent of iPhone 4s in the United States now running on Verizon
(Localytics)

64%
Percent of mobile phone app downloaders who played a game on their phones in the last 30 days
(Nielsen)

E-readers Double, Tablets Soar, But Devices Still In Infancy

Reduced pricing and new color models in the e-reader category (Kindle, Nook, Kobo, etc.) have contributed to the number of Americans who own them doubling, according to the Pew Internet & American Life Project. In November 2010, 6% of adults in the United States owned e-readers, but that spiked to 12% by May. Tablet ownership rose from 5% to 8% in the same period, with flatter growth after the 2010 holiday. Despite this remarkable growth rate in devices, both e-readers and tablets still have a long way to go to overtake older technologies such as MP3 players and DVRs:

Device Ownership in the United States (May 2011)

Cell Phone	83%
Desktop Computer	57%
Laptop Computer	56%
DVR	52%
MP3 Player	44%
E-reader	12%
Tablet	8%

Have You Ever Used Facebook To Learn More About Your Children's Dates?

Call it the rise of the iParent. According to Retrevo, moms and dads who own iPhones are considerably more likely to use Facebook frequently and to peek at their own kids' activities online.

All Parents	12%
Dads	13%
Moms	10%
iPhone-owning Parents	20%
Droid Parents	8%

Top Web Categories In Mainland China, Taiwan & Hong Kong

Category	% Share Of Total Online Minutes
Portals	24.4%
Entertainment	9.0%
Search/Navigation	6.2%
Social Networking	5.5%
Retail	5.0%

(comScore)

It's sheer coincidence, this month's Dream Hardware, but perhaps September 2011 is a fitting time to think on soldiers and sand.

BY MARTY SEMS

Solar-Sinter

"In the deserts of the world, two elements dominate—sun and sand," says UK design student Markus Kayser (www.markuskayser.com). "The former offers a vast energy source of huge potential, the latter an almost unlimited supply of silica in the form of quartz." Taking a detour from his solar-powered Sun-Cutter material burning project, and inspired by 3D printing processes such as SLS (selective laser sintering), Kayser created the Solar-Sinter. It focuses sunlight to fuse sand into glass. Kayser tested a manual version in Morocco in February. Next came an automated edition with computer-controlled table mechanisms, all powered by sunlight, and trials three months later in Egypt. Even in the Solar-Sinter's current, rough form, the idea of cranking out something as simple as building bricks using practically limitless resources gives a hint as to its potential. ■
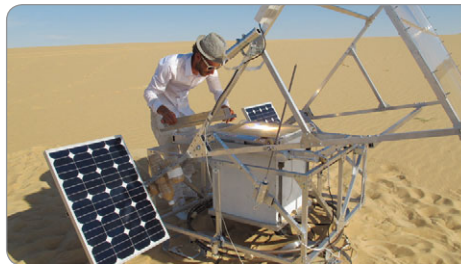
Poss Industries Jackal

BPG Werks' DTV Shredder (bpg-werks.com) is basically the Jet Ski of dirt biking. If you've ever wanted to tear it up while you're standing up, simply grab its handlebars and go. So then G.I. Joe marches in, and he wants one. Only with a hybrid powerplant. And remote control. And autonomous operation. And grenade launchers. Thus a spinoff was born (possindustries.com) to develop weatherproofed, dual-tracked vehicles for the military. The turbocharged, rotary engine is good for at least 28mph. Switch to battery power only, however, and you've got a stealth sand scooter. The Jackal is snow-capable, too, and it can take inclines of up to 45 degrees. Shoot, put a dirt track behind every recruitment office in the country, and the Jackal could solve the military manpower shortage by itself. ■
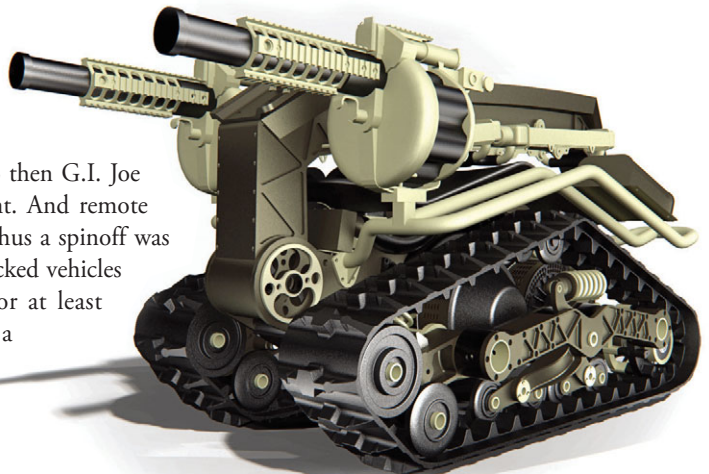
Winchester FlashDisk RV-2500

Speaking of the military, it's been using solid-state storage for a dogface's age. As you can guess, the ruggedness bullet point is the armed forces' primary target. At the same time, cost savings are always welcome. Enter Winchester Systems (www.winsys.com) with its new RV-2500 series of FlashDisk storage units. They have the features the military requires, namely rigidity and protection against dust and humidity, but cost about half as much as "fully" ruggedized products, Winchester says. Estimated prices are $89,500 for a 4.8TB SLC unit and $79,500 for a 9.6TB MLC edition, although these numbers will fluctuate with SSD prices. Winchester says that RV-2500s are already being deployed in Navy subs, Army battlefield shelters, and Air Force recon planes. ■
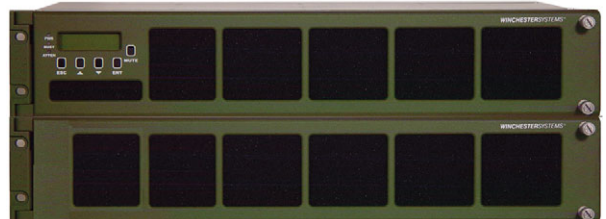
POWER UP WITH ANTEC'S
HIGH CURRENT GAMER PSUS

JUST LIKE YOU DON'T BUILD A CASTLE in a swamp, you don't build a powerful PC with an unreliable PSU.

Antec has long been perfecting its power supplies, as experienced users know. New from the respected marque is the quiet and powerful HCG line.

That acronym stands for High Current Gamer, signifying the standards of gamer-focused PSUs: efficiency, high-end construction, and gamer aesthetics. But these PSUs are also for any user looking for a great price/performance ratio. Think of it this way: The HCGs thrive on the rigors of modern gaming, which amply demonstrates their suitability for any computing task.

An 80 PLUS® Bronze rating emphasizes Antec's commitment to power efficiency in the HCG lineup. The Bronze certification means that at least 82% of input power goes directly to your PC instead of being dissipated as waste heat. All HCG models come with a 135mm double ball bearing fan for ample, quiet cooling.

Antec worked just as hard to make the HCGs rock-solid. Only Japanese-brand capacitors make it in. There's industrial-grade protection against overages of all kinds, plus anti-corrosive gold plating on the PSUs' terminals. The bottom line, or should we say bedrock, is that the HCG series has the reliability to back up its good looks.

Speaking of looks, the dash of red color complements the biker-bar black on the rigid, no-nonsense HCG chassis. All cables continue the black theme with high-quality mesh sleeving, along with their generous wire lengths and thoroughly modern array of connectors.

The best news of all is the HCG series' availability for all types of PCs. There are single-rail 400W, 520W, and 620W models, plus a pair of four-rail enthusiast editions in 750W and 900W trim. The latter come with a special five-year limited warranty. As for multi-card graphics configurations, the 520W and higher units are rated for SLI and CrossfireX.

Tell you what: If our words haven't convinced you to give Antec's HCGs a hard look, just listen to your pulse. ■

High Current Gamer
Antec
www.antec.com

SSD Slugfest
Six 6Gbps Drives Fight For Supremacy

Power users everywhere are enamored with solid-state storage technology. It's simultaneously fast and energy-efficient. SSDs are incredibly durable and remarkably compact. Really, prohibitive pricing is the only reason to shy away from sticking several hundred gigabytes of flash-based memory in your next rig. And yet, when we're presented with performance data from next-generation SSDs, the largest, most expensive models are usually the ones represented.

That's no accident, either. Controller logic at the heart of every SSD utilizes a number of different channels to which memory chips are attached. Populating all of those channels is a good first step to maximizing a given drive's throughput. Take Intel's value-oriented X25-V as an example. It's very similar to the mainstream X25-M, except that only five of the X25-V's 10 channels are active, and that's why the 40GB drive only writes up to 35MBps compared to the 80GB X25-M's 70MBps.

Beyond the number of occupied channels, the quantity of devices per channel matters, too. Each little memory package you see under the hood of an SSD hosts one, two, or even four NAND-based dies, depending on how much capacity the manufacturer wants to enable. A greater number of dies helps increase parallelization as the controller writes to each device, ultimately delivering better performance in workloads able to tax the SSD. The scaling isn't linear, but the increase in throughput is indeed measurable.

Why should you care so much about how SSDs are built? Because, the performance data tied to the largest models isn't always replicated in drives with less capacity. It turns out that the more affordable members of any given product family not only give up space but also sacrifice some speed.

The flashiest flagships are naturally the most attractive, but they also require generous budgets. We're much more comfortable recommending 120GB SSDs. They're large enough for an operating system and plenty of applications, relatively affordable, and generally offer impressive performance characteristics. But how do you pick a winner in today's competitive solid-state drive market? We grabbed six samples designed to pump data over a 6Gbps SATA interface and benchmarked them to help you choose.

How We Tested:

In order to replicate each drive's performance straight out of the box, we used Secure Erase to completely wipe them. We then ran a scripted suite of Iometer tests to measure theoretical performance. We created a partition on each SSD immediately afterward and then executed PCMark 7's secondary storage suite, followed by CrystalDiskMark 3.0.1b.

Adata S511 120GB

Without question, SSDs based on SandForce's current-gen SF-2200-series controller dominate this round-up. SandForce did a fantastic job of impressing enthusiasts with its rookie effort, the SF-1200, and the same partners who took the leap with SandForce then are now eagerly pushing out drives employing its latest creation. Performance was naturally at the top of the SF-2200's list of improvements, and Adata uses that more powerful controller to push sequential reads and writes as high as 550MBps and 510MBps, respectively. Those lofty transfer rates necessitate a 6Gbps storage controller, such as the one built into Intel's Z68 Express platform controller or AMD's SB950 southbridge.

Our Z68-based machine fell just shy of the company's expectations in Iometer, which uses compressible data that really cooperates with SandForce's architecture. Adata rates the 120GB S511 for up to 85,000 IOPS in random writes but doesn't cite a random read specification. We measured both using Iometer, though, and came up with more than 71,000 IOPS in the write test and 83,000 IOPS in 4KB random reads. In the rest of our simulated workloads, the S511's I/O performance was second only to Patriot's Wildfire,

S511 120GB
$239 | Adata
www.adata.com.tw

making this an incredibly performance-oriented SSD at a surprisingly low price, compared to the other contenders.

In addition to its 120GB model, Adata also sells 60GB, 240GB, and 480GB units. The entire lineup bears a 1,000,000-hour MTBF and is protected by a three-year warranty. Adata also

bundles a bracket for easy mounting in desktops without concessions for 2.5-inch SSDs. And the company makes a data migration utility (Acronis True Image HD) available to its customers, facilitating a smooth transition from mechanical disk to SSD for enthusiasts who don't relish the thought of reformatting.

Corsair Force Series 3 120GB

Corsair's Force Series 3 employs the same SandForce SF-2200 controller as the Adata S511. Like its competition, Corsair rates the Force Series 3 for sequential reads as fast as 550MBps and writes peaking at 510MBps. The drive even sports the same random 4KB write ceiling of 85,000 IOPS. Why, then, does it cost $30 less than the Adata offering?

There's one important specification that would be otherwise easy to overlook: The Force Series 3 employs older asynchronous NAND flash, while the S511 benefits from synchronous memory based on the ONFi 2.0 standard. The former is limited to 50MBps per channel but is less expensive, while the latter tops out at 133MBps and costs more.

It's easy to shrug off that seemingly gaping difference given our less alarming Iometer results. However, Iometer tests using compressible data, and SandForce's technology

Force Series 3 120GB
$209 | Corsair
www.corsair.com

deals with that information very efficiently. The incompressible data that CrystalDiskMark throws at the drives is far less forgiving of the slower memory, and we see sequential reads more than halved. All other metrics drop, as well, though random performance is impacted less since it's not bound by the

drive's throughput. Even PCMark 7, a synthetic benchmark designed around real components of Windows 7, quantifies the loss. Fortunately, most real-world tasks aren't as unfriendly to the SF-2200 controller.

Corsair generously rates the Force Series 3 drives with a 2,000,000-hour MTBF but maintains the same three-year warranty coverage as Adata. There's an adapter included to install the 2.5-inch Force Series 3 in a 3.5-inch bay, but Corsair doesn't bundle any software to help migrate from an existing hard drive-based installation. And like all of the other drives in this roundup (except Crucial's m4, which provides 119.24GiB), the Force Series 3 gives you 111.79GiB of usable space once it's formatted.

Crucial m4 128GB

In a market where SandForce's controller is the darling, Crucial's decision to use logic from Marvell instead is bold. But Marvell's 88SS9174 is hardly an underdog. After all, the company created the very first 6Gbps SATA controller, and Crucial used it as far back as January 2010 in its RealSSD C300. Thus, the m4 employs a second-gen version, which adds support for additional memory types. It still uses two ARM9 cores and 256MB of onboard cache. Of course, the SATA 6Gbps interface carries over, as well.

Crucial does a little juggling with its firmware to better optimize the m4 for a 6Gbps connection. Whereas the 128GB C300 pushed 355MBps in sequential reads and up to 140MBps in writes, the 128GB m4 delivers reads as high as 415MBps and writes up to 175MBps. Although that's much slower than the 256GB version's 260MBps write specification, we actually measured close to 190MBps in CrystalDisk-Mark, so Crucial's ratings appear conservative.

The tradeoff is purportedly lower 4KB random read

performance compared to the C300. Again, however, we clocked the 4KB random reads at

m4 128GB
$229 | Crucial
www.crucial.com

more than 85,000 IOPS using a queue depth of 32, whereas Crucial says to expect 40,000 IOPS. And although the 4KB random write spec maxes out at 35,000 IOPS, Iometer shows the m4 exceeding 41,000 IOPS. That's still less than the SandForce-based drives, but the m4 doesn't take the same hit when you throw incompressible data at it, which is why Crucial fares much better in CrystalDiskMark and PCMark 7.

You won't get a 3.5-inch adapter with the m4, nor do you receive data migration software. But Crucial does sell a special SKU with a data transfer kit for $20 more that includes a USB-to-SATA cable and EZ Gig III Cloning software. Warranty coverage on both versions lasts for three years.

OCZ Agility 3 120GB

Like Corsair's Force Series 3, the Agility 3 is armed with SandForce's potent SF-2200 controller and then summarily handicapped with asynchronous NAND flash. But don't take that harsh introduction as an indication of inferiority. In fact, OCZ's offering joins this roundup with a compelling advantage: It's the least expensive drive and the only one available for less than $200. In a number of metrics, the Agility 3 actually manages to sneak past the Force Series 3 by a few megabytes per second. The differences are

Agility 3 120GB
$199 | OCZ
www.ocztechnology.com

really pretty insignificant, though, leaving a $10 price gap as the most noticeable variable.

Whether or not the Agility 3 turns out to be right for you depends on the way you plan to use it. If you're working with a lot of compressible data (such as text files), then SandForce's architecture can help mitigate the impact of the Agility 3's asynchronous memory. Compare the Agility 3 and Vertex 3 using Iometer; aside from random 4KB write performance, they both do fairly well, exceeding 500MBps sequential read speeds and nearly achieving their rated 500MBps write data rate. Hammer the Agility 3 with already-compressed MPEG movies and ZIP files, though, and its sequential read speed is more than cut in half. But even when you're looking at incompressible data, random performance is still pretty reasonable on the Agility 3. Its flash is not bottlenecking the results.

It's hard not to like a 120GB SSD for $200. OCZ protects the Agility 3 with a three-year warranty. It doesn't include a 3.5-inch bracket, though, while Corsair's Force Series 3 does, so that could make up the $10 difference if your chassis can't easily accommodate a 2.5-inch SSD. With that said, a great price and modest performance make this a solid buy for price-sensitive power users.

OCZ Vertex 3 120GB

OCZ is the most well-known of SandForce's partners. Although it buys one company's controller, another company's memory, and puts them on a circuit board, similar to competing vendors, OCZ takes more liberties with the firmware controlling its SSDs. The result is a very broad range of drives that hit several

Vertex 3 120GB
$259 | OCZ
www.ocztechnology.com

performance levels. There are currently four product families in OCZ's SATA-based 6Gbps portfolio: the Vertex 3 Max IOPS Edition, the Vertex 3, the Agility 3, and the Solid 3, all employing an SF-2200 controller.

The Vertex 3 sits up near the top of the stack, second only to the niche Max IOPS drive. OCZ says the 120GB version is able to push sequential reads of up to 550MBps and writes as high as 500MBps, but our Iometer benchmarks fall just shy of that mark. Switching over to CrystalDiskMark's incompressible workload has a small impact on sequential reads, but sequential writes fall through the floor, just as we saw from Adata's S511. In that situation, the two Marvell-based drives are faster, as is Patriot's highly tuned Wildfire.

OCZ turns the tables on those three SSDs by serving up better random 4KB reads and writes at low queue depths, which is what most desktop users will experience. As soon as you shift into a more demanding environment with lots of pending commands, however, Crucial's and Patriot's SSDs again pass the Vertex 3. The Vertex 3 includes a 3.5-inch drive bracket and a three-year warranty. Its price tag seems appropriate in light of performance. But Adata's S511 SSD delivers near-identical specifications for $20 less, making it a better value.

Patriot Wildfire 120GB

Patriot put a bit of extra work into its 120GB Wildfire. The drive centers on a now-familiar SF-2200 controller. However, it unequivocally puts down the best sequential and random I/O performance in our roundup. Though it fails to hit the 555MBps reads and 520MBps writes that Patriot claims, we measured the Wildfire's sequential read throughput at 536MBps and write bandwidth at 489MBps in Iometer. CrystalDiskMark hits the SandForce-based

drives harder with its workload, and that's where this SSD pulls away from the competition, sustaining nearly 500MBps reads and 250MBps writes as other second-gen SandForce drives slow down more substantially.

Low queue depths aren't kind to the Wildfire's random performance, but Patriot's drive pulls away yet

Wildfire 120GB
$299 | Patriot
www.patriotmemory.com

again when we hit it with 32 pending commands in the same 4KB read and write tests. Our Iometer workloads concur with the CrystalDiskMark suite, returning exceptional results in all four scenarios and greater than 80,000 IOPS in both 4KB random I/O measurements. PCMark 7 sums up all of those benchmark results by awarding the Wildfire a first-place finish in its secondary storage suite.

Of course, Patriot knows its SSD is fast, and the company pins a very high price tag to best-in-class performance. In an enterprise environment that prioritizes random I/O, Patriot's exceptional read and write speed could be the key to getting more done in less time, saving money. But does a 50% premium over the Agility 3 translate into 50% more performance on the desktop? Decidedly not.

Patriot gets recognition for making an already-fast SandForce-based solution even faster. However, a lofty price quickly erodes the drive's value when you calculate its cost per gigabyte and compare it to competing 6Gbps SSDs.

Off To The Races

Of the six drives we tested, four push sequential reads that are so fast that they require a competent 6Gbps SATA controller; make sure you have a modern

motherboard able to accommodate nearly 500MBps of throughput. The other two—Corsair's Force 3 and OCZ's Agility 3—are less adept at handling CrystalDiskMark's random mix of 0s and 1s, and drop to transfer rates that a 3Gbps controller could handle. With that said, the Force 3 and Agility 3 are also the two least expensive options. So long as you're moving compressible information, both drives deliver impressive sequential performance for well under $2 per gigabyte.

The three faster SandForce SF-2200-based SSDs are priced higher but handle incompressible files more deftly. They also post better random I/O numbers at higher queue depths, indicating a propensity for environments pushing lots of concurrent activity. Patriot deserves special recognition for demonstrating the best sequential read and write speeds, along with incredible random read/write results at a queue depth of 32. The drive doesn't fare quite as well at a queue depth of 1, but its Iometer results are simply unmatched.

All six SSDs fall within $100 of each other, a substantial range to be sure. Would you notice a performance difference between the most and least expensive? Not in most desktop environments. To that end, the Force Series 3 and Agility 3 look like good bargains. And for just $20 and $30 more, respectively, Crucial's m4 and A-Data's S511 add smoking-fast sequential performance to the equation, as well. ■

BY PAUL CROSS

Benchmark Results	AData S511 120GB	Corsair Force 3 120GB	Crucial m4 128GB	OCZ Agility 3 120GB	OCZ Vertex 3 120GB	Patriot Wildfire 120GB
	$239	$209	$229	$199	$259	$299
CrystalDiskMark 3.0*						
Sequential Read	469.37	207.98	405.48	206.92	463.08	497.34
Sequential Write	168.55	145.13	187.48	147.66	168.52	246
Random 512KB Read	421.52	199.48	367.18	197.97	415.17	447.64
Random 512KB Write	168.14	145.29	188.54	147.63	168.06	248.54
Random 4KB Read (QD=1)	30.39	26.17	24.58	25.36	28.96	29.64
Random 4KB Write (QD=1)	89.32	88.42	61.11	75.52	81.36	63.64
Random 4KB Read (QD=32)	104.7	90.81	245.83	93.46	104.74	179.49
Random 4KB Write (QD=32)	163.72	141.85	167.49	143.42	163.76	214.3
PCMark 7						
HDD Test Suite	5091	4672	5137	4696	5093	5192
Windows Defender*	5.52	5.38	5.5	5.37	5.51	5.49
Gaming*	16.69	15.65	16.3	15.65	16.7	16.68
Windows Photo Gallery import*	23.89	21.32	25.12	21.53	23.77	26.62
Windows Movie Maker video edit*	23.12	21.65	22.72	21.67	23.12	23.25
Windows Media Center*	8.25	8.18	8.2	8.18	8.25	8.25
Windows Media Player music add*	1.41	1.4	1.4	1.4	1.41	1.41
Application loading*	49.44	35.86	52.73	36.85	49.85	50.83
Iometer (QD=32)						
Database Workload	26,639 IOPS	23,710 IOPS	19,605 IOPS	23,667 IOPS	26,454 IOPS	33,075 IOPS
Web Server Workload	14,584 IOPS	13,322 IOPS	14,699 IOPS	13,323 IOPS	14,457 IOPS	19,642 IOPS
File Server Workload	20,554 IOPS	18,599 IOPS	13,643 IOPS	18,575 IOPS	20,375 IOPS	26,276 IOPS
Workstation Workload	23,663 IOPS	21,232 IOPS	20,749 IOPS	21,330 IOPS	23,572 IOPS	32,576 IOPS
Streaming Reads (2MB)*	536	536	528	536	536	536
Streaming Writes (2MB)*	491	488	179	489	492	489
4KB Random Reads	83,374 IOPS	82,164 IOPS	85,248 IOPS	82,281 IOPS	83,278 IOPS	86,868 IOPS
4KB Random Writes	71,495 IOPS	56,390 IOPS	41,036 IOPS	56,765 IOPS	71,587 IOPS	81,193 IOPS

*results in MBps

Test system specs: CPU: Intel Core i7-2600K; Motherboard: Gigabyte Z68X-UD7-B3; GPU: Nvidia GeForce GTX 560 Ti; RAM: 8GB Crucial DDR3-1333; Storage: Intel SSD 510 250GB; Intel Rapid Storage Technology 10.1.0.1008.
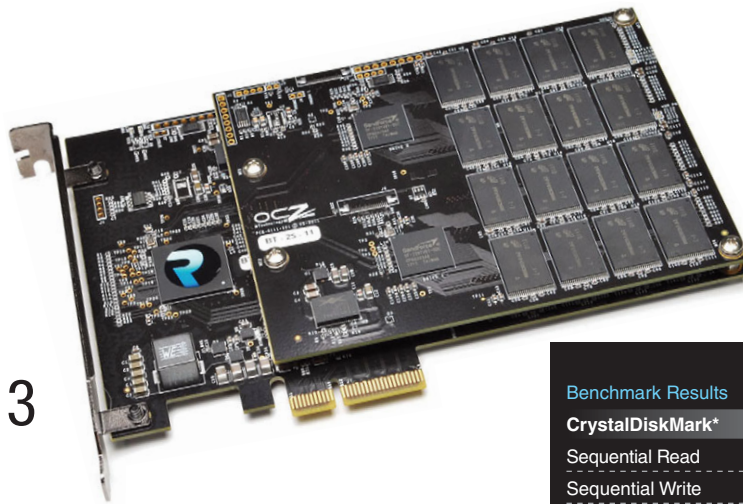
OCZ RevoDrive 3 X2 480GB

OCZ has been on a tear as of late, bringing new SSD technologies to market targeted for all types of end users, as well as enterprise customers. The company was one of the first suppliers to market with a PCI-E-based offering that was priced low enough to be at least approachable for the average power user or workstation professional.

The RevoDrive 3 X2 is OCZ's latest incarnation of their consumer-grade PCI-E SSD line of products that was introduced last year. The first-generation product employed SandForce SF-1200 series 3Gbps SATA controllers along with a Silicon Image RAID controller and a PCI-X to PCI-E bridge. More elegantly, the RevoDrive 3 makes use of a proprietary RAID controller (ARM-based), which OCZ has dubbed the SuperScale storage processor, that has both PCI-E and 6Gbps SATA interfaces on board and connect to SandForce's latest SF-2200 series 6Gbps SATA SSD controllers. With four of these controllers on the RevoDrive 3 X2, as you can imagine, performance is at drag race speeds.

The RevoDrive 3 X2, with its mezzanine-style, stacked-PCB design, boasts insane 1,500MBps max read and 1,250MBps max write specifications. OCZ achieves this performance in part due to technology the company calls VCA (Virtualized Controller Architecture) 2.0. Through a combination of load balancing algorithms and CCQS (Complex Command Queuing Structure) that employs both Native and Tagged Command Queuing, OCZ's SuperScale processor on the RevoDrive 3 X2 maximizes resource utilization and performance across the card's array of SandForce SSD controllers. Not only that, the RevoDrive 3 X2 can support both TRIM commands and SMART monitoring, which is a first for a single-card SSD RAID product.

Another feature that has been added to the RevoDrive 3 lineup in general is power fail protection and sleep state support. This was one of the few reservations we had with the first-gen RevoDrive product. Though our RevoDrive 3 X2 prototype didn't quite have this feature working yet, we're told retail cards will have the ability to drop into system standby and then recover via onboard non-volatile memory that is in place to support delayed transactions.

Regardless, what will attract speed freaks and workstation professionals will be the RevoDrive 3 X2's performance. Hands down it's one of the fastest PCI-E SSDs on the market right now and easily the most reasonably priced when you consider several-thousand-dollar alternatives from Fusion-io, LSI, and others. At $1,699, the 480GB X2 card we tested weighs in at a little over $3.5/GB, which isn't bad if you consider the RevoDrive 3 X2 is currently almost three times as fast as the average 6Gbps SATA SSD. ■

BY Dave Altavilla

RevoDrive 3 X2 480GB
$1,699.99
OCZ
www.ocztechnology.com

Benchmark Results	OCZ RevoDrive 3 X2 480GB
CrystalDiskMark*	
Sequential Read	685.5
Sequential Write	544.5
512K Read	560.5
512K Write	527.9
4K Read	21.13
4K Write	94.06
4K QD32 Read	385.8
4K QD32 Write	512.4
PCMark Vantage HDD*	
Windows Photo Gallery	486.73
Windows Defender	349.88
Vista Startup	508.6
Gaming	329.95
Windows Media Center	625.23
Windows Movie Maker	297.64
Application Loading	465.7
Media Player	270.52
ATTO Disk Benchmark*	
4K Transfer Read	310,419
4K Transfer Write	232,046
32K Transfer Read	1,063,976
32K Transfer Write	955,908
512K Transfer Read	1,118,481
512K Transfer Write	1,398,795
1MB Transfer Read	1,161,499
1MB Transfer Write	1,412,818
8MB Transfer Read	1,214,350
8MB Transfer Write	1,402,750
IOMeter 2010	
Workstation - QD 144	78,092 IOPS
Database - QD 144	91,150 IOPS
4K Writes, Random - QD 128	140,083 IOPS

*results in MBps
Specs: Maximum read/write (advertised): 1,500MBps/1,250MBps; Maximum 4KB write (advertised): 230,000 IOPS; Interface: PCI-E 2.0 x4; MTBF: 1,000 hours; Three-year warranty
Test system specs: Processor: Core i7-970 CPU; Motherboard: Gigabyte EX58 Extreme; GPU: Nvidia GeForce GTX 285; RAM: 6GB Kingston DDR3-1333; Storage: WD Caviar Black 1TB; Windows 7 Ultimate x64

Sapphire Radeon HD 6870 FleX

It's been a while since AMD christened the chip that launched the Radeon HD 6000 series, but Sapphire proves with its new FleX edition that the Radeon HD 6870 still has legs. At first glance, the Sapphire Radeon HD 6870 FleX is nearly indistinguishable from AMD's reference 6870. It has a 900MHz core clock, a 1,050MHz memory clock, and a 256-bit memory bus paired with 1GB GDDR5. The GPU in this card features 14 SIMD (single instruction multiple data) engines in it for a total of 1,120 stream processors, 56 texture units, and 32 ROPs. Moreover, this card has the same heatsink and shroud as Sapphire's vanilla 6870, exchanging the chrome plastic accents for blue ones.

Sapphire has two vanilla 6870s, and the FleX version takes after the one that sports two mini DisplayPorts. The HDMI port is adjacent to two DVI ports, one single-link and the other dual-link.

With all these display ports, you'd probably think this would make a great multimonitor card, and you'd be right. As a FleX graphics card, the Sapphire Radeon HD 6870 FleX is hardwired to enable three DVI monitors, two via the DVI ports on the backplane and a third from the passive HDMI-to-DVI adapter bundled with the card. On a non-FleX card, you'd need an active DP-to-DVI port adapter to enable Eyefinity, and those adapters aren't cheap. You can also use the remaining mini DPs to connect two more monitors, for up to five total.

Another standout feature of this card, and most of Sapphire's cards for that matter, is the quality heatsink and shroud combo. This one has a copper base and a trio of thick copper heatpipes piercing a thick, finned chunk of aluminum. With solid-state caps and Black Diamond chokes, you know this card is built for reliable performance. Paired with Sapphire's TriXX overclocking suite, this card can only get faster. The suite is much more granular than AMD's own OverDrive utility, which gives you sliders to manipulate the core and memory clocks. TriXX lets you do the same, but also provides access to the GPU voltage. Obviously, use it at your own risk.

In the benchmarks, the Sapphire Radeon HD 6870 FleX performs the same as a stock-clocked 6870. As you can see, that's enough to best a mildly overclocked GeForce GTX 560. Sapphire's card narrowly emerged victorious in Just Cause 2, but it turned out a much bigger performance advantage in Metro 2033 and Aliens vs. Predator.

If you're a serious gamer who wants to broaden your horizons with Eyefinity, we can't think of a better option currently available. ■

BY ANDREW LEIBMAN

Radeon HD 6870 FleX
$199.99
Sapphire
www.sapphiretech.com

Specs & Scores	Sapphire Radeon HD 6870 FleX	Nvidia GeForce GTX 560
Price	$199.99	$189.99
Core clock	900MHz	830MHz
Memory clock	1,050MHz	1,002MHz
Memory interface	256-bit	256-bit
Memory	1GB GDDR5	1GB GDDR5
3DMark 11 Performance		
3DMark Overall	P4226	P4118
Graphics Score	3844	3739
Physics Score	9019	9120
Combined Score	4025	3882
Graphics Test 1	19.01	17.79
Graphics Test 2	19.06	18.11
Graphics Test 3	24.27	23.78
Graphics Test 4	10.75	10.81
Physics Test	28.63	28.95
Combined Test	18.72	18.06
Unigine Heaven 2.5		
FPS	19.9	20.4
Score	502	514
Games	**1,920 x 1,200**	
Metro 2033 (High Quality, AAA, 4XAF)	27	19.67
Just Cause 2 (4XAA, 16XAF)	58.53	57.91
Aliens vs. Predator (4XAA)	31.2	27.1
	2,560 x 1,600	
Metro 2033 (High Quality, AAA, 4XAF)	14	11.67
Just Cause 2 (4XAA, 16XAF)	40.88	41.46
Aliens vs. Predator (4XAA)	19.3	16.2

Driver: Catalyst 11.6, Forceware 275.33

Test system specs: Processor: 3.47GHz Intel Core i7-990X; Motherboard: Intel DX58SO2; RAM: 6GB Patriot Sector 7 DDR3-1600; Storage: 600GB WD Raptor; PSU: Antec TruePower Quattro 1200

Specs: GPU: Barts XT; Core clock: 900MHz; Memory: 1GB GDDR5 (1,050MHz); 1,120 Stream Processors; 56 texture units; 32 ROPs

Sapphire Radeon HD 6770 FleX

Sapphire's latest take on the Little GPU That Could, aka Juniper, is the Radeon HD 6770 FleX. Sapphire offers several versions of the 6770, but this one is aimed at budget gamers looking for the multimonitor path of least resistance.

The Radeon HD 6770 FleX features the same clocks as Sapphire's vanilla 6770 (and AMD's stock card), an 850MHz core and 1,200MHz memory clock. There's a 128-bit bus and 1GB GDDR5 for frame buffering. The R840 GPU in this card is the same one found in AMD's Radeon HD 5770. In fact, this card's shroud sticker still bears the ATI logo that AMD kicked to the curb almost a year ago. There are 10 SIMD (single instruction multiple data) engines, 800 stream processors, 40 texture units, 64 Z/Stencil ROPs, and 16 color ROPs under the hood. The dual-slot card features a CrossFire connector; 6-pin power port; and HDMI, DisplayPort, and two DVI (one single-link, one dual-link) outputs on the backplane.

Between the 5770 and 6770, AMD updated the card's firmware to support HDMI 1.4a and Blu-ray 3D playback. As a member of Sapphire's exclusive FleX family of graphics cards, this one features dedicated logic onboard that lets you hook it up to a trio of DVI displays without requiring a costly active adapter, which is a boon to users looking to create their own Eyefinity setups. With the dual-slot copper and aluminum heatsink strapped to this card, we'd take that a step further and call it a boon to overclockers, as well.

To see for ourselves, we ran AMD OverDrive (built into AMD's Catalyst Control Center utility) to overclock this card to 950MHz. We also managed to add 135MHz to the memory clock. As you can see, the higher clocks made themselves most apparent at the lower resolution. Just Cause 2, for instance, gained almost 5 frames per second, which is an improvement you'll be able to see in-game. We also tested the Radeon HD 6770 FleX against a reference 5770 AMD sent us eons ago, and the performance difference between what are essentially the same GPUs was, frankly, stunning.

For kicks, we tried to overclock the 5770, and got the 700MHz core and 1,150MHz memory clocks to 850MHz and 1,180MHz, respectively. While impressive, they did not hold up under the rigors of 3DMark 11; the synthetic benchmark only completed when we backed off to 830MHz.

The 5770 then buckled when we tried to run the games, but with Sapphire's solid lead, we decided to put the 5770 out to pasture.

This card is a good buy for anyone looking for Eyefinity on the cheap, but we'd recommend limiting yourself to three monitors. ■

BY ANDREW LEIBMAN

Radeon HD 6770 FleX
$139.99
Sapphire
www.sapphiretech.com

Specs & Scores	Sapphire Radeon HD 6770 FleX	Sapphire Radeon HD 6770 FleX (OCed)	Radeon HD 5770
Price	$139.99	$139.99	~$125
Core Clock	850MHz	950MHz	700MHz
Memory Clock	1,200MHz	1,335MHz	1,150MHz
Memory Interface	128-bit	128-bit	128-bit
Memory	1GB GDDR5	1GB GDDR5	1GB GDDR5
3DMark 11 Performance			
3DMark Overall	P2764	P2984	P2254
Graphics Score	2453	2654	1973
Physics Score	8955	9015	8985
Combined Score	2551	2794	2139
Graphics Test 1	12.37	13.57	9.97
Graphics Test 2	12.41	13.44	9.81
Graphics Test 3	15.15	16.3	12.39
Graphics Test 4	6.78	7.29	5.46
Physics Test	28.43	28.62	28.53
Combined Test	11.87	13	9.95
Unigine Heaven 2.5			
FPS	11.4	12.6	9.7
Score	288	318	245
Games	**1,920 x 1,200**		
Metro 2033 High Quality, AAA, 4XAF)	16.67	18	15
Just Cause 2 (4XAA, 16XAF)	39.88	44.55	33.61
Aliens vs. Predator (4XAA)	19.4	21.5	16.2
Games	**2,560 x 1,600**		
Metro 2033 High Quality, AAA, 4XAF)	9	9.67	8.33
Just Cause 2 (4XAA, 16XAF)	26.43	29.02	22.12
Aliens vs. Predator (4XAA)	11.9	13.2	10
Driver: Catalyst 11.6			

Test system specs: Processor: 3.47GHz Intel Core i7-990X; Motherboard: Intel DX58SO2; RAM: 6GB Patriot Sector 7 DDR3-1600; Storage: 600GB WD Raptor; PSU: Antec TruePower Quattro 1200

Thermaltake Frio OCK

The Thermaltake Frio OCK has a commanding presence for a CPU cooler. Coming down the pike with six copper heatpipes, the Frio OCK gets its bulk from a dual-heatsink tower design and the square fan module (or "360 degree protective armor," according to folks at Thermaltake). The fan cover serves as a full metal jacket of cooling power, with four vented corners that contour both fans; the color scheme practically begs you to use the Frio OCK in a Starcraft II-themed mod. The behemoth that is the Frio OCK stands 158.4mm tall from head to toe, so keep that in mind when considering it for your chassis.

Thermaltake shipped a foam-padded accessory kit with the cooler, complete with compartments for every bracket and bolt set. The back plate was a snap to attach, and securing the heatsink to the CPU wasn't excessively time-intensive. It helps that you can install the heatsink first and clamp on the fan module afterward.

When the Frio OCK's fans (powered by one three-pin connector) are set at the lowest rpm (1,200), you could rock a baby to sleep next to your tower. Turning the fan knob to high (up to 2,100rpm) will produce 48dB of not-so-quiet white noise, but bear in mind that this doesn't come close to the din of a high-end graphics card's fan under load. At its max rpm, the Frio OCK can produce a hurricane-force 121 cfm airflow. In other words, if you're the type who regularly subjects your system to punishing workloads, you won't be disappointed with the Frio OCK's massive airflow capabilities.

We mounted the Frio OCK in a rig sporting an Intel Core-i7 980X attached to a Gigabyte X58A-OC motherboard. This system also included two Zotac GeForce GTX 580s in SLI,

Frio OCK
$79.99
Thermaltake
www.thermaltakeusa.com

6GB of Crucial Ballistix DDR3-1600, and a 128GB Crucial RealSSD C300.

We performed several tests to put the Frio OCK through the ringer. According to RealTemp, ramping up the fan to 2,100rpm dropped the idle temperature to 27 degrees Celsius. To tax the 980X's six cores, we used Prime95. For each core, we created a separate Prime95 app, chose the Torture Test, and selected In-Place Large FFTs (which maximizes heat, tests power consumption, and stresses some RAM). There were no hiccups for the Frio OCK or the Intel cooler: The i7 easily passed the 1024K, 896K, and 768K tests. The load temp reached 62 C, as compared to Intel's stock 980X cooler's 65 C.

We also ran POV-Ray and selected the Render All CPUs benchmark. The load temp jumped, as expected, to 54 C. The Intel cooler shot right past that, though, cresting 61 C. We also benched the Frio OCK with RealTemp's single thread XS

test, where it scored a 1376. Intel's stock cooler showed a 1379.

In our fourth bench, Orthos Stress Prime 2004 blended CPU and RAM test, the Frio OCK didn't have to work quite as hard. Maxing at 49 C, the Frio OCK fared well during the 10-minute trial. Comparatively, the stock cooler reached 52 C.

The Frio OCK is a quality replacement for your stock CPU cooler, and the price isn't bad when you consider the significant cooling capabilities. If for some reason you're not so jazzed about this mighty cooler, there's always Thermaltake's slightly more modest, and slightly slimmer, sister cooler, the Frio CLP0564 ($64.99).

All in all, easy installation, solid scores, and impressive airflow help Thermaltake's Frio OCK prove itself worthy of any mid or full tower build. ■

BY JOANNA CLAY

Specs: Socket compatibility: Intel LGA775/1155/1156/1366, AMD AM2/AM2+/AM3; Materials: Aluminum (fins, base), copper (base); Weight: 1,093g (with fans); Fans: 2 130mm (1,200 to 2,100rpm) Acoustics: 21 to 48dB(A); Max airflow: 121 cfm; Dimensions: 158.4 x 136.8 x 143mm (HxWxD)

LEPA

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Model	G900-MA	G700-MA	G500-MA
Power	900W	700W	500W

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Modular Design

80 PLUS® Gold Certified
Peak 93% efficiency

Silent Cooling
13.9cm thermal programmed speed controller fan

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Facilitates installation with bottom-mounted PSU chassis

Graphic Connector
8P PCI-E supporting extreme graphic cards

SATA power connectors with 3.3V rail
Supports new generation SSD

Excellent Protections
Over Power/Voltage/Current, Short-Circuit, and Brown Out circuits

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850W**

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80 PLUS® Bronze Certified
Peak 88% efficiency

High effciency 5Vsb circuit
helps system to meet EU ErP Lot 6 2010 requirements

Silent Cooling
13.5cm fan with intelligent RPM control

60cm CPU Connector
Facilitates installation with bottom-mounted PSU chassis

Graphic Connector
8P PCI-E supporting extreme graphic cards

SATA power connectors with 3.3V rail
Supports new generation SSD

Excellent Protections
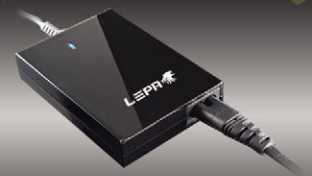Over Power/Voltage/Current, Short-Circuit, and Brown Out circuits

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Product Showcase

Enclosure

iPad Cover
w/Bluetooth Keyboard

iPad Leather Cover

Ultra Slim
Notebook Adapter

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FSP Aurum CM Gold 750

In July, we reviewed FSP's Aurum Series Gold 700 and found that it offered solid performance and great efficiency. The Aurum CM Gold 750 power supply is a slightly higher-wattage model with partially modular cabling. Built-in cables include the 20+4-pin main power, two EPS12V (one 8-pin and one 4+4-pin), and one PCI-E with two 6+2-pin connectors.

FSP designed the Aurum CM Gold 750 with four +12V rails that each offer up to 18A. The maximum combined power the four +12V rails can deliver is 720 watts. The 3.3V and 5V outputs each provide a maximum output current of 30A apiece and together deliver a maximum combined power of 160 watts. As you can likely guess by its name, the Aurum CM Gold 750 offers a total continuous power of 750 watts and is 80 Plus Gold-certified.

One of the things we really like about the Aurum Series Gold 700 was the short 7-inch length (including cable bend). The Aurum CM Gold 750 is slightly longer, at 7.8 inches with the cable bend. But the modular design also means that you'll have more flexibility with your cabling.

FSP blends the connectors, as well as the cable length, on the peripheral power cables. For example, there's a short 27-inch cable with only one SATA and one Molex connector. You'll also find one 43-inch cable with two SATA connectors and three Molex connectors. The convenient mix made it easy for us to attach peripheral cables that perfectly matched the power needs and cable lengths necessary to reach the devices in our case, so we weren't left with a lot of excess cable sitting inside the case.

In all, you'll find eight SATA connectors, five Molex connectors, and one floppy connector. FSP includes enough PCI-E connectors to power high-end dual-GPU setups. There are four PCI-E cables (two hardwired, two modular) that each split off into two 6+2-pin PCI-E power connectors.

Much of the 80 Plus Gold efficiency of the Aurum CM Gold 750 is due to FSP's MIA (Multiple Intelligence Ability) IC technology. The MIA circuit in the power supply is responsible for controlling the unit's pulse width modulation, reducing current switching losses, power factor correction, post synchronous rectifying, and overvoltage protection. Each of the above features typically has its own dedicated circuit in a traditional power supply; by combining them, FSP is able to waste less energy and more efficiently control the power in the Aurum CM Gold 750.

In our testing, we were able to push the Aurum CM Gold 750 all the way up to a maximum wattage of 793 by simultaneously running POV-Ray beta and the Aliens vs. Predator benchmark. At 793 watts, the power supply delivered a power factor of .980. At 50% loads, the Aurum CM Gold 750 generally provided a power factor of around .99.

We experienced no hiccups during installation or testing the Aurum CM Gold 750. It's a solid option for enthusiasts wanting an energy-efficient PSU for a system running up to two graphics cards. ■

BY NATHAN LAKE

Aurum CM Gold 750
$179.99
FSP
www.fspgroupusa.com

Specs	FSP Aurum CM Gold 750
Rated continuous (W)	750 (at 40 C)
12V rails	4
+12V max (A)	18
+5V max (A)	30
+3.3V max (A)	30
SLI/CrossFire-certified	No
Max wattage tested	793
Power factor tested	.98
Efficiency rating (as advertised)	90%
Cable side	Motherboard
Fan location	Bottom
Fan(s)	120mm
PCI-E	4 (6+2-pin)
Main 12V	20+4-pin
EPS12V	2 (8-pin, 4+4-pin)
SATA	8
4-pin Molex	5
Floppy	1
Length (including cable bend)	7.8 inches
Warranty	5 years

Test system specs: Processor: Intel Core-i7 980X; Motherboard: Gigabyte X58A-OC; GPU: Zotac GeForce GTX 580 (2x, SLI); RAM: 6GB Crucial Ballistix Dominator DDR3-1600; Storage: 128GB Crucial RealSSD C300

Corsair Professional Series HX1050

In a relatively short period of time, Corsair has built a well-deserved reputation for offering quality power supplies at competitive prices. The latest addition to the company's lineup, the 1,050W Professional Series HX1050, is Corsair's second-most powerful PSU (only the 1,200W AX1200 has a higher rating) that's targeted at high-end gaming PCs and workstations.

The HX1050 PSU features a mostly modular design with a textured matte black finish and large 140mm cooling fan. The unit sports a single, powerful +12V rail that can handle a maximum load of 87.5A, along with 30A 3.3V and 5V rails. Although it's not formally certified for SLI or CrossFire, the HX1050 is more than capable of supporting multiple graphics cards and includes six 6+2-pin PCI-E power leads. Despite its relatively high power ratings, though, the 7-inch-long HX1050 is one of the smaller high-end units to make its way through the lab.

Throughout testing, the Corsair HX1050's performance was excellent. We stressed this power supply with a fully decked-out dual-Xeon X5680-powered rig, featuring Evga's 2P Classified SR-2 motherboard, complete with 24GB of RAM, a pair of 2GB Radeon HD 6970 graphics cards, and multiple expansion cards, hard drives, and SSDs. Regardless of the workload, the HX1050 never faltered. Even after hammering on the unit with a 910W+ load for an extended period, it remained perfectly stable and quiet. The Corsair HX1050's 140mm cooling fan does spin up as workloads exceed the 60% mark, but even when loaded this PSU is quiet.

With a current street price hovering around $229, the Corsair HX1050 won't be the cheapest PSU on the shelf, but it is more affordable than many other units with similar power ratings. The bottom line: If you're in the market for a high-end PSU, then Corsair's HX1050 demands serious consideration. ■

BY MARCO CHIAPPETTA

Professional Series HX1050
$239.99
Corsair
www.corsair.com

Specs	Corsair Professional Series HX1050
Rated continuous (W)	1,050 (at 50 C)
12V rails	1
+12V continuous (A)	87.5
+5V continuous (A)	30
+3.3V continuous (A)	30
SLI-certified	No
CrossFire-certified	No
80 Plus-certified	Silver
Max wattage tested	916W
Case temp as tested	55 C
Power factor as tested	0.99
Efficiency rating (as advertised)	Up to 88%
Cable side	Motherboard
Fan location	Bottom
Fans	140mm
PCI-E	6 (6+2)-pin
Main 12V	24 pin
8-Pin EPS12V	2 (2 4+4 pin)
SATA	12
4-Pin Molex	12
Floppy	2
Finish	Matte black, textured
Length (including cable bend)	7.75 inches
Warranty	7 years

ARCTIC MC001-BD

Spend enough time noodling around with a media extender, a "smart" TV, a DVR, and other home-theater gadgets, and you might come to the conclusion that what you really need is an HTPC. After dealing with the limitations of consumer electronics, you might appreciate having a big hard drive, an unfettered Internet connection, and the ability to add whatever interface, codecs, and input devices you like.

Then again, you probably don't want a full-sized PC in your living room. Hence it's the realm of compact systems with HD power, but quiet operation.

The ARCTIC MC001-BD is the Blu-ray model of ARCTIC's Entertainment Center line of Atom-based systems. Think of it as a slim PC that comes with Windows 7, CyberLink PowerDVD 10, and Windows Live Essentials security software preinstalled. A minimal amount of new-PC setup later, you've got a quiet Windows Media Center box that can disappear in your home-theater equipment.

ATI Mobility Radeon HD 5430 graphics drives an HDMI port with 1080p power. Realtek supplies 7.1-channel surround sound. Blu-ray playback was smooth after some initial caching. So was playback of locally stored HD video files.

The MC001-BD is silver on one side and gloss black on the other, which lets you orient it to match your decor. It stands on one end, so you can slip it behind an HDTV on a stand or next to an A/V receiver in a cabinet. It does not, however, come with a VESA mount to hang it on your wall or TV.

Nor does the MC001-BD come with a remote, although ARCTIC sells one for just $17.90. The box and Web site also mention free downloads to turn your iOS or Android device into a remote; they may be available by the time you read this.

At first glance, ARCTIC's choice of 32-bit Win7 Home Premium puzzled us. It seemed odd for the company to leave roughly 700MB of the 4GB of RAM on the table.

Then we noticed the included RAMDisk software from Dataram. It's intended to utilize that untapped memory as a RAM disk, i.e., using DDR as hard drive space for items you'd like to speed up (not including boot files). Our test system was set up with a 700MB RAM drive with its own drive letter. The MC001-BD's SO-DIMMs are upgradable if you'd like more capacity.

Because RAM is volatile, meaning that it loses its data as it loses power, you can set up RAMDisk to automatically load a specialized drive image file of your apps, temp file, VMware OS, or what have you when you turn on your PC. (Note that because the RAMDisk software loads after Windows boots, it precludes using its capacity for a swap file.) At shutdown, the software can save changes to the image file on the hard drive. You can also save a new drive image whenever you want, if you want to save a work in progress.

Alternatively, you can manually load sensitive information to the RAM drive and consider its volatility a security feature, Dataram says—turn off your PC, and the data goes away. Whichever configuration you ultimately choose, it's clear that RAMDisk is worth exploring.

Another nice surprise is the included HDMI cable. Add ARCTIC's wireless keyboard with multi-touchpad ($45.90), and you're ready to chill. ∎

BY MARTY SEMS

MC001-BD
$714
ARCTIC
www.arctic.ac

Specs: Dimensions: 10.8 x 6.1 x 1.7 inches (HxWxD); Processor: 1.8GHz Intel Atom D525; Chipset: Intel NM10; Graphics: ATI Mobility Radeon HD 5430 512MB; RAM: 4GB DDR3-1333; Hard drive: 500GB Hitachi Travelstar 7K500 (7,200rpm); ODD: Slimtype BD E DS4E1S 4X BD-ROM; Connectivity: 802.11b/g/n, Gigabit Ethernet, 2 USB 3.0, 5 USB 2.0, IR, HDMI 1.3a, VGA, optical digital audio, 7.1-channel analog audio, headphone jack, mic in, 4-in-1 card reader

MSI

MSI Z68 (G3) MAINBOARDS

FUTURE-PROOF YOUR PC WITH PCI-E 3.0 & UEFI

Once in a blue moon, you'll get the opportunity to "future-proof" your PC—that is, to install tomorrow's tech today. We're not talking about proprietary innovations of dubious staying power; we're talking about cutting-edge technology that represents the standard going forward.

This brings us to MSI's new line of Z68 motherboards. Not only do they support Intel's upcoming Ivy Bridge processors, hotly anticipated next year, they also come with the third generation of PCI-Express, the technology that connects it all.

PCI-E 3.0 effectively doubles the throughput of PCI-E 2.0, all the while maintaining backward compatibility with earlier devices. Each PCI-E 3.0 lane is capable of 1GBps data transfer in either direction. This means that an x16 PEG slot can flip up to 32GBps in total. Whether you're a gamer, an SSD RAIDer, or a user of GPU-accelerated software, that's real news.

Another next-gen standard is the replacement for the 1980s BIOS. A Unified Extensible Firmware Interface is much more than a pretty GUI and support for big boot drives.

Enter MSI's ClickBIOS II, a UEFI with click-and-drag functionality, accelerated bootup, system readings in real time, and even touchscreen support. Consider it the click of death for the clunky, blue-screen BIOS of yore.

Of course, MSI builds these boards to last. The company commandeers Military Class II components such as high-c tantalum capacitors, low-temp ferrite chokes, and exclusively solid capacitors. Going the extra mile in hardware selection pays dividends in stability and longevity, the company says.

MSI offers Military Class Components and 5 Year Warranty on Z68A-GD80 (G3) and Z68A-GD65 (G3)
MSI | us.msi.com

MSI doesn't stop there. The Z68 (G3) boards come with Intel Smart Response SSD caching, THX Certified Audio, easy OC Genie II overclocking, and LucidLogix Virtu switching between a GPU and the CPU's integrated graphics. There's even a Super Charger feature to boost USB power to your recharging tablet, phone, or other mobile device.

Factor in a long, five-year warranty, and it's clear that this series of MSI boards is an investment for the long term. ■

MSI Sleek and Robust UEFI BIOS Interface.

Rosewill Thor V2

A few years back it would have been difficult to imagine needing a desktop motherboard any larger than the familiar ATX specification, which measures 12 inches wide and 9.6 inches long. But technologies like three-way SLI and four-way CrossFire are capable of eating up every single expansion slot on a typical ATX board. A handful of decidedly enthusiast-class platforms employ the roomier 13.5 x 10.3-inch XL-ATX form-factor, facilitating extra space for multiple dual-slot graphics cards.

Although the list of enclosures able to accommodate those big motherboards is equally short, it does include Rosewill's new Thor chassis. Naturally, the all-black case is large, measuring almost 23 inches tall, 22 inches deep, and a little less than 10 inches wide. It's also heavy; a steel frame and plastic trim pieces weigh more than 30 pounds without any hardware installed.

The design is attractive, though. Mesh covers much of the front and right side of the case. Together with a well-ventilated rear-end, the Thor promotes the sort of airflow needed to keep a graphics-heavy configuration cool. Rosewill further capitalizes on its free-flowing configuration by adding one 140mm and three 230mm fans to its bundle. You can plug all four coolers directly into motherboard headers. Or, use the two-channel fan controller integrated onto the enclosure's front panel.

In addition to that pair of knobs able to control two fan speeds, Rosewill enables two USB 3.0 ports, two

USB 2.0 ports, an eSATA connector, and audio I/O up front. Unfortunately, the USB 3.0 leads aren't compatible with the internal interface found on most motherboards. Instead, you route them through the case and plug them into back-panel ports, essentially trading a pair of rear-facing ports for the front two. Otherwise, all of the corresponding data and power cables are long enough to easily plug in-to motherboard headers.

While the Thor's front, back, and sides are fairly standard-looking, its top features an array of fins and a switch to control it. Closed, the blades sit flat and the surface is sealed off, defeating the purpose of a top-mounted fan. Enthusiasts are more likely to leave the fins open, angled upward to allow airflow. Inside, the case's bottom-mounted power supply tray is a matter of personal preference. Just make sure your PSU of choice comes with cables that reach the top of your favorite motherboard.

Building with the Thor is a pleasure, in part because its gargantuan dimensions leave lots of room to work in without scraping a knuckle. Even foot-long add-in cards like AMD's Radeon HD 6990 fit without an issue. Additionally, concessions for cable management make it really easy to set up a very clean PC. A series of cut-outs in the motherboard tray let you weave power and SATA cables in and out, hiding the rat's nest typical of systems with high-end graphics and lots of storage. It's a shame, then, that the side

panel isn't windowed; you can't see past the black mesh.

Because it's so large, the Thor accommodates up to six 5.25-inch drives externally and six 3.5-inch drives internally. Rosewill's specs also claim support for a pair of external 3.5-inch drives. However, that space is actually shared. Installing a floppy drive and a card reader, for example, limits you to four external 5.25-inch bays. The hard drive bays accommodate 3.5-inch mechanical storage and smaller 2.5-inch SSDs.

Best of all, priced at $150, the Thor is one of the least-expensive chassis able to take an XL-ATX-based platform with room for as many as 10 expansion slots. When you're spending big bucks on three or four GPUs, every extra bit of value helps. ■

BY PAUL CROSS

Thor V2
$150
Rosewill
www.rosewill.com

Specs: Dimensions: 22.84 x 9.14 x 21.89 inches (HxWxD); Motherboard Support: mATX, ATX, EATX, XL-ATX; Weight: 30.42lbs; Bays: 4 external 5.25-inch, 2 external 3.5/5.25-inch, 6 internal 3.5/2.5-inch; Fans: 1 rear 140mm, 1 front 230mm (red LED), 1 top 230mm, 1 side 230mm; Front I/O: 2 USB 2.0, 2 USB 3.0, 1 eSATA, 2 fan control knobs, headphone, mic; Warranty: 1 year limited

Geekbox Prodigy

There are two things enthusiasts love about the inexorable march of technology: the record-breaking performance of the cutting-edge parts, and ever smaller and cooler components capable of running enthusiast applications in significantly less space. With the Prodigy, Geekbox shows us the current state of small form factor systems, and frankly, we love what we're seeing.

Not To Be Underestimated

Geekbox's Prodigy comes installed in SilverStone's SG05-450 SFF case, which measures 6.9 x 8.7 x 10.9 inches (HxWxD). Pictures don't do it justice; this is a whole PC that you could put in overhead storage on your next flight and still have enough linear inches to bring along a full-sized keyboard, mouse, headset, and 20 ounces of your favorite high-caffeine beverage. Yeah, and it'll put your notebook to shame.

We tested the Geekbox Prodigy at PDXLAN 18 in Portland, and although it wasn't the flashiest PC on display, it garnered more than a few double-takes.

Under the slick-looking Grigio Scuro Ferrari Dark Grey case panel you'll find Gigabyte's GA-H67N-USB3-B3 Mini-ITX motherboard, which measures 6.7 inches square and packs quite a punch in the form of support for Intel's second-gen Core processors, aka Sandy Bridge. Geekbox gave us the quad-core Intel Core i5-2500K, which supports overclocking but has a standard 3.3GHz core clock and a 3.7GHz Turbo Boost clock. There's no Hyper Threading on this processor, so the four logical cores are all the operating system and multithreaded software will see. Intel's stock heatsink and fan cool this 95-watt processor. Geekbox also installed a pair of 4GB Mushkin PC3-12800 DDR3 modules for a total of 8GB of system memory.

As an Intel Core i5-2500K, this processor features on-die graphics in the form of Intel's HD Graphics 3000 logic, which has an 850MHz base frequency. But Geekbox knows we have a reputation to maintain, so they crammed an Evga GeForce GTX560 Ti into the Prodigy.

Aside from the keen paint job, the storage subsystem was the other aspect Geekbox diverged from the Prodigy's base specification. By default, the Prodigy comes with a more-than-capable 1TB Western Digital Black Edition 6Gbps HDD. For another $275, Geekbox added a 128GB Crucial RealSSD C300 as the boot drive, which makes a big difference in the responsiveness of the system, especially on startup or when loading games. Seconds after boot up, we were fragging in TF2. Geekbox also included a slim optical drive in the form of the LG DVD-RAM/±R/±RW drive and installed Windows 7 Home Premium 64-bit.

Geekbox ships the Prodigy with a one-year part replacement and free shipping warranty as well as lifetime in-store and telephone support. You can add a year or two for an additional $99 and $199, respectively.

No Napoleon Complex

Despite its size, the Geekbox Prodigy lives up to its name and delivers scores you'd expect from a full-sized desktop PC. The only thing you're really missing out on with Geekbox's petite package is expandability and upgrade options. But as a mostly mobile gaming PC (good luck getting a monitor under the seat in front of you), the Prodigy is an impressively performing compact PC. ■

BY ANDREW LEIBMAN

Prodigy
$1,824 as tested
Geekbox
www.geekbox.com

Specs & Scores	Performance PC 3D HTPC
Price	1824
3DMark 11 Performance	
3DMark Overall	P4099
Graphics Score	3868
Physics Score	6364
Combined Score	3779
Graphics Test 1	18.33fps
Graphics Test 2	18.41fps
Graphics Test 3	22.96fps
Graphics Test 4	11.71fps
Physics Test	20.20fps
Combined Test	17.58fps
PCMark 7	
PCMark Score	4757
Productivity Score	4901
Creativity Score	4652
Entertainment Score	4745
Computation Score	3955
System Storage Score	5214
POV-Ray 3.7 RC3	
Pixels Per Second	985.54
Cinebench 11.5	
Points	5.41
Unigine Heaven 2.5	
FPS	22.6fps
Score	570
Game	**1,920 x 1,200**
Aliens vs. Predator (4XAA)	30.2fps

Specs: Processor: Intel Core i5-2500K (3.3GHz); Motherboard: Gigabyte GA-H67N-USB3-B3; Graphics: Evga GeForce GTX560 Ti; RAM: 8GB Mushkin PC3-12800; Hard drive: 1TB Western Digital Black Edition, 128GB Crucial RealSSD C300; ODD: LG DVD-RAM/±R/±RW; PSU: 450W SilverStone

Trendnet 450Mbps Concurrent Dual Band Wireless N Router (TEW-692GR)

Benchmark Results	Trendnet TEW-692GR	Trendnet TEW-671BR
Sandra 2011 SP4 Wireless (WLAN/WWAN) test*		
Maximum rate (2.4GHz/5GHz)	108/112	94/96
Average rate (2.4GHz/5GHz)	74/85	55/64
*results in Mbps		

Trendnet's 450Mbps Concurrent Dual Band Wireless N Router (model TEW-692GR) is a dual-band router that provides theoretical download speeds of 450Mbps for both the 2.4GHz and 5GHz bands. We tested the TEW-692 against one of Trendnet's first 300Mbps dual-band routers, the TEW-671BR, and found that there was a decent jump in throughput between the two models.

The TEW-692GR features three antennas that are hardwired to the unit. Each antenna can rotate almost 360 degrees horizontally and be folded up or down. Trendnet includes a stand to vertically orient the router, and there are rubber feet on its bottom side to help it stay in place if you want to lay it flat. Like most of today's routers, there are four wired LAN ports.

Trendnet has also added a variety of features to make the router more convenient and secure to use. Both the 2.4GHz and 5GHz bands support three additional virtual SSIDs, which is ideal if you want to set up different security for specific network users or guests. For example, you could set up one SSID with security for guests, where they are allowed access to the Internet but not content on local network computers. Trendnet also includes WPS (Wi-Fi Protected Setup) for configuration that's as simple as pushing a button, as well as WDS (Wireless Distributed System) support to let you easily expand your network using wireless access points that need no wired connection.

Gamers and video streaming fans will like that the TEW-692GR includes both customizable QoS (Quality of Service) settings and WMM (Wi-Fi Multimedia). QoS of High, Middle, and Low (as well as the router's default setting) are available, and you can customize the percentage of bandwidth guaranteed to each group. Enabling WMM ensures that audio, video, and voice applications will be set at a High QoS priority, so streaming content and video chats appear as smooth as possible when Internet traffic is busy.

Lastly, Trendnet includes its GREENnet power-saving technology to reduce the amount of power the router uses. For example, the TEW-692GR can detect when an Ethernet port is idle and put it into standby mode until it receives a signal. GREENnet can also determine the length of any attached Ethernet cables, so that signals aren't given more power than needed to reach a destination.

We connected a notebook to the router using Trendnet's TEW-684UB 450Mbps dual-band USB adapter. To benchmark the TEW-692GR, we ran SiSoftware Sandra's 2011 SP4's Wireless (WLAN/WWAN) test that provides current Wi-Fi data bandwidth. Because there are so many factors that can affect Wi-Fi performance, we tested the speed by moving the notebook to several locations around the house. We noted

the maximum speed recorded, as well as the average of the five different locations. To test the dual-band ability of the router, we ran the Wireless (WLAN/WWAN) test for 2.4GHz and 5GHz bands. Then, we connected Trendnet's 300Mbps dual-band TEW-671BR router using the same method.

The TEW-692GR showed a 14.9% (2.4GHz) and 16.7% (5GHz) increase in maximum bandwidth over Trendnet's TEW-671BR. The TEW-692GR produced max speeds of 108Mbps for the 2.4GHz and 112Mbps for the 5GHz band, and, on average, it delivered 74Mbps in the 2.4GHz range and 85Mbps in the 5GHz range. We'll also note that the drop between the maximum and average speeds was less with the TEW-692GR than the TEW-671BR, thanks in large part to the TEW-692GR's extra available antenna and radio stream. (The TEW-671BR has only two antennas/streams.)

The TEW-692GR proved to provide performance increases, and we like the features built into the router. All in all, it's a good choice if you're looking for a new 802.11n router. ■

BY NATHAN LAKE

TEW-692GR
$179.99
Trendnet
www.trendnet.com

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ineo iPile Series USB 3.0 External Hard Drive Module

Now that USB 3.0 is showing up in many PCs (so far, almost always in tandem with legacy USB 2.0 ports, of course), the question arises: Is there a good way to use your extra 2.5-inch 1.5/3.0Gbps SATA drives and still take advantage of the increased throughput offered by USB 3.0? And of course the answer is yes.

The ineo iPile Series USB 3.0 External Hard Drive Module is a simple and elegant solution to the issue of extending the life of your 2.5-inch 1.5/3.0Gbps SATA drives. Consisting of a simple SATA-to-USB 3.0 adapter and an off-white, suede-lined leather-like pouch with a hook-and-loop closure, the product is easy to set up and use: Just plug the adapter into your drive, drop the unit into the pouch, and connect the included USB Micro-B cable. Done.

What will you gain? Well, in theory, USB 3.0 gives you transfer speeds of up to 10 times that of USB 2.0. Isn't theory great? We didn't get anywhere near that, but we did see significant improvement in throughput. Using USB 2.0, it took 26.2 seconds to transfer a 681MB file to the drive and 42 seconds to transfer a 1.08GB file. Using the same 2.5-inch drive and the same computer, but with the drive connected via a USB 3.0 port, we transferred the 681MB file in 11.7 seconds and the 1.08GB file in 17.5 seconds. Nothing like a 10x improvement, but well over twice as fast as USB 2.0.

The pouch is a convenient mode of protected transport (just drop the device into your backpack or even in a jacket pocket), and with the USB 3.0 adapter you can now repurpose your 2.5-inch legacy SATA drives for data backup, transport, media editing, and more, while taking advantage of the improved performance of USB 3.0. ■

BY ROD SCHER

iPile External Hard Drive Module
$24.99 (online)
ineo
www.neo2tech.com

Specs: Adapter connectivity: 1.5/3.0Gbps SATA to USB 3.0/2.0; Maximum data transfer rate: 3Gbps; Case: leather-like with access hole and hook-and-loop closure; USB 3.0 cable included

Seagate Savvio 10K.5 900GB

Although SSDs have garnered the lion's share of press lately, advancement continues in the hard drive space. Take Seagate's new Savvio 10K.5 900GB (model ST9900805SS), for example. All told, the drive is rated for average sustained transfers in the 168MBps range, with random read and write seek times of 3.7 and 4.1ms, respectively. The three-platter Savvio 10K.5 achieves this kind of performance through the use of proprietary controller and firmware optimizations, along with its 10,000rpm spindle speed and an ultra-dense areal density of 506Gb per square inch platters.

The Savvio 10K.5 900GB put up some very respectable performance numbers in our testing, with single-drive transfers in the 130 to 169MBps range and some of the lowest access times we've seen from a spinning-platter hard drive.

At around $600 a pop, the Savvio 10K.5 900GB is one of the most expensive 10,000rpm hard drives available, but it is also one of the highest performing. Plus, its capacity is currently unmatched by anything in its class. ■

BY MARCO CHIAPPETTA

Savvio 10K.5 900GB
$574.99 (online)
Seagate
www.seagate.com

Benchmark Results	Seagate Savvio 10K.5 900GB
HD Tune v 4.61	
Transfer Rates (read/write)	
Average*	131.2/130
Min.*	83.5/81.7
Max.*	173/162.9
Burst Rate*	339.2/289.9
Access Time (ms)	7.41/3.25
CPU Usage (%)	0.8/0.09
CrystalDisk Mark x64 v3.0.1 (read/write)*	
Seq. Transfers	169.3/168.7
512K Transfers	72.47/115.9
4K Transfers	1.05/2.77
4K QD32 Transfers	3.23/2.79
SiSoft Sandra 2011	
File System	
Drive Score*	134.44
Random Access Time (ms)	4.1
PCMark 7	
HDD Test Suite	2493
Windows Defender*	2.44
Gaming*	6.86
Windows Photo Gallery import*	11.07
Windows Movie Maker video edit*	19.65
Windows Media Center*	7.88
Windows Media Player music add*	1.27
Application loading*	5.42
*results in MBps	

Specs: Capacity: 900GB; Form factor: 2.5-inch (15mm Z-Height); Interface: 6Gbps SAS; Cache: 64MB; Spindle speed: 10,000rpm; Sustained transfer rate (advertised): 168MBps; Average latency: 3.0ms; Random seek time (read/write): 3.7ms/4.1ms; I/O transfer rate: 600MBps; MTBF: 2,000,000 hours; Warranty: Five-year warranty
Test system specs: Processor: Intel Core i7-2600K; Motherboard: Asus P8Z68-V PRO; RAM: 8GB G.Skill DDR3-1600; GPU: Geforce GTX 280; Storage card: HighPoint RocketRAID 2720; Windows 7 Ultimate 64-bit

Patriot Wildfire 240GB

When buying an SSD, there's often an element of heightened performance that comes with buying a larger SSD. In this issue's roundup of 120GB drives, we showed you Patriot's smaller Wildfire drive, but how about its bigger brother? Do you get more than just a doubling of capacity for nearly twice the price?

The 240GB Wildfire uses the same 32nm MLC NAND, SandForce SF-2200 controller, and 6Gbps SATA interface as its little sibling. (Patriot will also offer a 480GB Wildfire.) For both drives, Patriot advertises sequential read and write times of 555MBps and 520MBps, respectively, and up to 85,000 random write (4K aligned) IOPS.

In general, the performance difference we see between the 240GB and 120GB Wildfires was largely negligible. The 240GB unit lagged behind in 4K operations with a queue depth of 32. However, our PCMark 7 scores show the incremental improvement we expected to see in the move to having more die resources on the same 8-channel memory architecture.

Bottom line: The Wildfire 240GB remains a screaming fast drive and a terrific entrant in the 6Gbps field. If you're looking for a performance edge through higher capacity, you'll find some here, but just don't expect a night and day difference over the 120GB Wildfire. ■

BY WILLIAM VAN WINKLE

Wildfire 240GB
$549.99
Patriot
www.patriotmemory.com

Benchmark Results	Patriot Wildfire 120GB	Patriot Wildfire 240GB
	$299	**$549.99**
CrystalDiskMark 3.0*		
Sequential Read	497.34	508
Sequential Write	246	244.1
Random 512KB Read	447.64	453.7
Random 512KB Write	248.54	250.9
Random 4KB Read (QD=1)	29.64	26.9
Random 4KB Write (QD=1)	63.64	92.45
Random 4KB Read (QD=32)	179.49	158.5
Random 4KB Write (QD=32)	214.3	207.1
PCMark 7		
HDD Test Suite	5192	5409
Windows Defender*	5.49	5.61
Gaming*	16.68	16.99
Windows Photo Gallery import*	26.62	30.42
Windows Movie Maker video edit*	23.25	23.43
Windows Media Center*	8.25	8.27
Windows Media Player music add*	1.41	1.41
Application loading*	50.83	56.33
Iometer (QD=32)		
Database Workload	33,075 IOPS	34,244 IOPS
Web Server Workload	19,642 IOPS	23,050 IOPS
File Server Workload	26,276 IOPS	28,585 IOPS
Workstation Workload	32,576 IOPS	35,362 IOPS
Streaming Reads (2MB)*	536	537
Streaming Writes (2MB)*	489	485
4KB Random Reads	86,868 IOPS	93,017 IOPS
4KB Random Writes	81,193 IOPS	50,239 IOPS

*results in MBps
Specs: Maximum read/write (advertised): 555MBps/520MBps; Maximum 4KB write (advertised): 85,000 IOPS; Interface: 6Gbps SATA; Three-year warranty
Test system specs: Processor: Intel Core i7-2600K; Motherboard: Intel DP67BG; GPU: GeForce GTX 480; RAM 8GB OCZ Gold DDR3-1333; Storage Transcend TS60GSSD25D-M 60GB; Intel Rapid Storage Technology 10.1.0.1008

ineo I-NA216U Plus USB 3.0 External Hard Drive Module

We took a look at ineo's impressive (and impressively simple) I-NA216U Plus USB 3.0 External Hard Drive Module. That's a long name for a very basic, functional product consisting of a simple SATA-to-USB 3.0 adapter and a protective plastic case. The unit is easy to install and easy to use: Just plug the plastic adapter into the 3Gbps SATA connectors on the back of your 2.5-inch drive and plug in the included USB Micro-B cable. Drop the assembly into the plastic case and snap the lid closed; a snug-fitting cocoon of plastic with just enough air trapped inside to provide a bit of a cushion cradles the drive.

And that's it. Assembly—such as it was—complete. You now have a SATA drive that's ready to connect to one of your computer's USB 3.0 ports. When you do, you'll notice a significant increase in throughput compared to using USB 2.0. Although our 1.5Gbps SATA drive didn't deliver the max 10x increase in speed that the USB 3.0 spec promises is possible (after all, even a 3Gbps SATA drive will fall short of USB 3.0's 5Gbps ceiling in the real world), we did see data transfer speeds of well over twice that delivered by USB 2.0 with the same drive and computer.

Note that the included 10-inch cable is convenient for carrying and storing, but the short length may leave your drive dangling, depending on how far your USB ports are from a surface on which you can safely rest the encased drive. If there's no access to a flat surface and you're not comfortable letting the drive dangle, you can always pick up a slightly longer cable for a few bucks.

The ineo I-NA216U Plus USB 3.0 External Hard Drive Module is convenient, useful, and affordable, and that's a combination that's tough to resist. ■

BY ROD SCHER

I-NA216U Plus USB 3.0 External Hard Drive Module
$19.99 (online)
ineo
www.neo2tech.com

Specs: Adapter connectivity: 1.5/3.0Gbps SATA to USB 3.0/2.0; Maximum data transfer rate: 3Gbps; Material: Plastic; USB 3.0 cable included

Frankenrouter
Power & Cooling Mods For Your Wireless Router

We tend to focus mainly on mods related to core PC components here in the Hard Hat Area, but there are other equally interesting and exciting mods that exist outside the box, so to speak. Although modding video cards, processors, and cases can result in extreme performance or head-turning aesthetics, there are times when more humble, practical mods better enhance the day-to-day computing experience. Let us explain.

For most power users, a fast Internet connection is an absolute must. Network slowdowns, intermittent connections, or complete outages trump all else and turn that hot rod of a rig into a nearly useless pile of expensive microchips. Without a reliable Internet connection, many power users simply can't do anything meaningful, fun, or productive with their systems. Unfortunately, many of these same users think they are solely at the mercy of their ISP, which couldn't be further from the truth.

Of course, problems can and do occur on an ISP's network from time to time, and they are mostly out of an end user's control. Not all connection issues are the result of a problem on the ISP's end, however. Some users may be surprised to find that their broadband routers could be responsible for a number of the day-to-day annoyances that affect the reliability of their broadband connections, including slowdowns or outages.

A Bit Unstable

Years ago, sharing an Internet connection between two (or maybe even three) systems was common. Today, though, we have far more connected devices in our homes making almost constant use of that broadband connection. In fact, according to a recent study conducted by Verizon, the average

Many wireless broadband routers will run hot, and possibly be unstable, when constantly under a sustained load by multiple devices. By enhancing the router's cooling and upgrading its power supply, you can restore stability and consistent performance.

home now has more than four Internet-connected devices.

But this is *CPU*—we know many of you scoff at that number and are anything but average. I myself have no fewer than 18 connected devices in my home at any given time: five desktop systems, three laptops, an HTPC, a Samsung "Smart" HDTV and Blu-ray player, three NAS boxes, a TViX media tank, an Xbox 360, and two smartphones. And that number can jump higher if I have guests over or am fixing a friend's PC, etc.

Although they're not all constantly pulling down huge files, the sheer number of connected devices making use of that broadband connection can put a heavy workload on a standard broadband router.

On a typical workday, for example, it wouldn't be uncommon for the router in the above scenario to run for hours on end with greater than 50 to 60% CPU utilization and countless bits transferred over its wireless radio. On those taxing days, the router would be exceedingly hot to the touch, and the connection would be flaky at best. Large downloads would fail. Sites wouldn't render completely. Doing anything online was generally subpar.

Through some troubleshooting and research, we came to find out that the ISP wasn't to blame for everything and that many power users across the Web have suffered through similar fates, all due to their routers. And we're not talking about low-end, el cheapo routers here, either.

The disassembly process will vary from router to router. Our Asus RT-N16 required nothing more than the removal of a few screws on its underside before we were able to open it. Be careful not to force anything open when disassembling your router, though, to ensure no wires, connections, or internal antennas are damaged or broken when pulling open its case.

Some very popular and powerful routers simply weren't up to the task of handling these heavy workloads.

Of course, there happen to be some effective workarounds that helped breathe new life into their routers and stabilize their broadband connections, some of which we're going to talk about here.

What Do I Need?

Not surprisingly, like an ill-configured PC, an overheating or underpowered router can be unstable and act erratically. Performing a few relatively simple mods, however, can remedy the situation. Take, for example, the Asus RT-N16. The RT-N16 is one of Asus' more popular wireless broadband routers. It is affordable, compatible with open-source firmware alternatives such as Tomato and DD-WRT, and powered by a speedy Broadcom SoC that runs at 480MHz out of the box (but is easily overclocked to 533MHz).

The Asus RT-N16 has many of the features enthusiasts crave in a router, but some users have reported overheating or instability when the router has been taxed for an extended period of time. Others have reported that the stock 12V DC power brick, which is rated for 1.25A, doesn't have enough juice to power the router when under a heavy workload.

We should also note that problems like these certainly aren't exclusive to the Asus RT-N16, but because we have one in house we'll use it as our guinea pig.

Counteracting the overheating and instability issues requires a few effective cooling mods and replacement of its power brick with something more capable. While we're focusing on the RT-N16 here, keep in mind, again, that you can apply the principles of this mod to virtually all routers.

To start, we needed to score a few parts and components. To be more specific, we'll need some small heatsinks like those used on motherboard chipsets and RAM chips, a low-profile cooling fan, some thermal epoxy/adhesive, some Goo Gone (or an equivalent cleanser), isopropyl alcohol, and a 12V DC power brick or adapter rated for at least 2A. And, of course, we'll be using our trusty toolkit complete with soldering iron (and solder), a multimeter, wire strippers, screwdrivers, and the like.

We were lucky enough to have all of these items lying around in our spare parts bin. Should you need to buy everything, it shouldn't cost much. You can find an array of chipset heatsinks for under $15, thermal adhesive for around $10, and a fan for a couple of bucks, max. Various online retailers sell more capable power bricks for less than $10; you can find the lowest prices on eBay.

Let's Mod

We began this mod by disassembling the RT-N16. All that was required to open up the case was removing four screws on the underside of the unit. With the screws removed, we simply pulled the case open to reveal the PCB within. (Please take special care during the disassembly process of your router to ensure that no internally mounted antennas or wires are fixed to the panels being removed, so as not to damage them.)

All of the Asus RT-N16's major heat-generating components are easily accessible right on the top side of its PCB. In roughly the center of the PCB is a large chip with a heatsink already attached. This is the Broadcom SoC. To one side are a couple of RAM chips, adjacent to a Broadcom network switch controller. And on the other side is the wireless radio, shielded in a thin metal casing. It's most important to cool the SoC
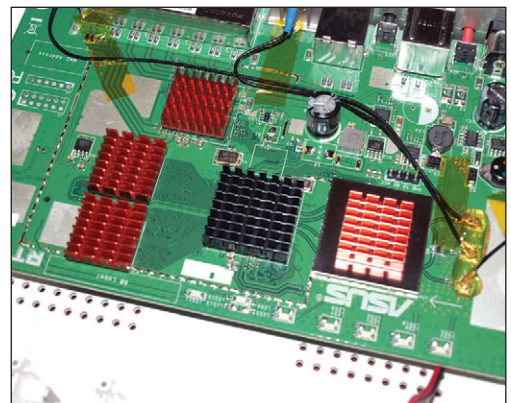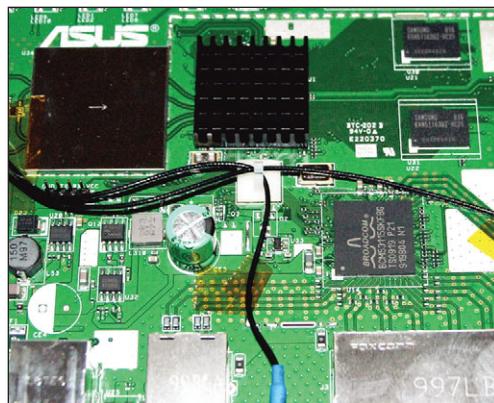
The Asus RT-N16 router we used for this project had a 12V DC input, which, with a little work, we could use to directly power a cooling fan. The positive and negative pins for the power input jack were accessible on the underside of the PCB, so we simply soldered a 3-pin fan plug (using only two leads, the positive [red] and negative [black]) to the power input for our cooling fan. In lieu of the fan plug, however, the fan's power leads can be directly soldered to the contacts, as well.
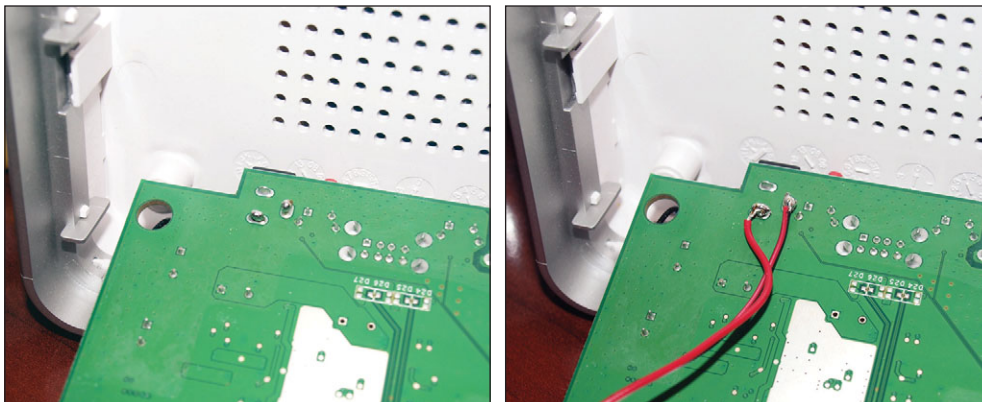
Inside a typical wireless broadband router, you'll find some RAM chips, a network switch controller, the wireless radio, and a SoC (System-on-Chip). It's the SoC that generates the most heat, but better cooling for all of the chips will help keep internal temperatures down and potentially enhance stability (and even overclockability, if your router's SoC is overclockable).

adequately, but we wanted to pull as much heat from all of the components, so we gave all of them some attention.

Our first order of business was to remove the stock heatsink. On the Asus RT-N16, the stock heatsink is held in place by thermal tape. With our particular device, the thermal tape had bubbles underneath, which severely hinders heat transfer. We gently twisted the stock heatsink to remove it and then peeled off the thermal tape. Using some Goo Gone, we then removed the leftover adhesive residue and cleaned the SoC and underside of the heatsink with some alcohol.

Next, we cleaned the surfaces of all of the other chips with more alcohol and cleaned the undersides of the spare memory heatsinks we had available.

With all of the surfaces prepped, we then readied the thermal adhesive. Thermal adhesive is a lot like thermal paste, but with a hardening agent added in. We mixed equal parts of the paste and hardening agent that make the adhesive and then applied thin layers to all of the chips, as we would have done with simple thermal paste. We pressed the heatsinks in place and weighted each of them down with a stack of coins on top to ensure good contact.

Once the thermal adhesive had dried (we gave it a couple of hours), we moved on to the fan installation. The Asus RT-N16 has about a 1/2 inch of open space above the SoC, which was enough room

to install a cooling fan inside the chassis. If your router doesn't have the room to fit an internal cooling fan, cutting a notch in the enclosure to accommodate the fan would work. Using a laptop cooler is another option.

We salvaged a small cooling fan from a decrepit old graphics card. We easily mounted this fan to the inside of our router's lid using a couple of small screws. The holes in the fan mounts didn't perfectly line up with the perforations in the lid, but we did manage to get two screws to bite. For reinforcement (and to minimize any vibration), we also installed a strip of double-sided tape underneath.

Next, we had to find a way to supply power to the fan. Since the fan itself required 12V to operate and our router used a 12V DC power supply, we decided to connect the fan right to the power source. To do so, we soldered the positive (red) and negative (black) leads from a 3-pin fan connector to the positive and negative posts in the router's power connector. We flipped the PCB over and used our multimeter to ascertain the polarity of the posts. Then we simply soldered the positive and negative leads to their respective posts. At that point, all we had to do was plug the fan in to give it power.

Our final step of the mod was to replace the stock power brick. We had an extra 12V power adapter available that luckily had a connector that fit our router and a power rating of up to 4A, which was more than adequate. In some cases cutting off the stock connector and soldering it to the new power brick may be necessary. Should you have to re-solder the connector, be sure to get the polarity correct.

Success!

After performing these mods to our router, it no longer felt warm after many hours of hard use, and stability improved dramatically. In fact, even after overclocking the router's SoC to 533MHz, the router has remained perfectly stable for weeks.

Although a misbehaving router may not be the root cause of every broadband
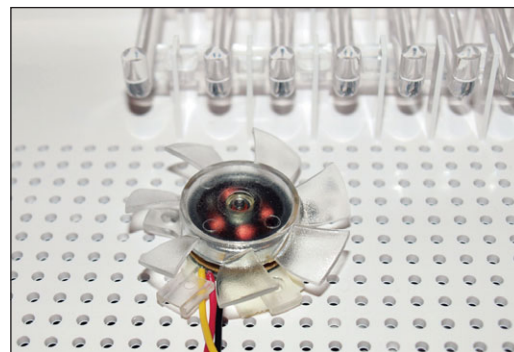
We salvaged a small cooling fan from a broken video card and screwed it right into the perforated lid on our router to securely mount it. We could only align two screw holes with the perforations, though, so we installed a small piece of double-stick tape under the fan to ensure it wouldn't move.

connection issue, we advise checking yours if you've had similar experiences as ours. With a few bucks' worth of parts and a little ingenuity, you may be able to resolve any power- and heat-related instability, which will definitely enhance the usability of your broadband connection. ▲

BY MARCO CHIAPPETTA

Diablo Azul

Lee "PCJunkie209" Harrington is no stranger to the pages of *CPU*. Pages 40 and 41 of the March 2011 issue featured his big, bad F&G Project, a Mountain Mods U2-UFO case with all sorts of custom work containing not one, but two complete systems (one for Folding@Home, one for gaming). That's right, he Folds, he games, he mods . . . and, as you'll see in a page or two, he overclocks!

We first encountered his Diablo Azul mod at Intel LAN Fest InfernaLAN in June, where it won *CPU* and Intel's LAN Fest mod contest. Then it showed up again at Asus' excellent ROG Formula X event and managed to pull out another win. The competition was tough, to be sure, but the Blue Devil is a thing of beauty; Harrington says he spent over 500 hours on the build.

Harrington built the aluminum frame from scratch, added some acrylic paneling for support, then vacuum-molded five layers of carbon fiber into a three-sided panel that slides on over the frame. The case includes a Mountain Mods motherboard tray, and Harrington had to make minor modifications to his Koolance 452X2 dual-bay reservoir so that he could turn it sideways for a different look.

He then sleeved his PSU cables in blue and white, painted the tops of the motherboard heatsinks white, and painted blue and white stripes on his graphics card, all to give Diablo Azul its striking color theme.

Diablo Azul contains an Asus P6T motherboard running an Intel Core i7-950. Other components include 24GB of Corsair Vengeance memory, an Asus GTX580 DirectCU II, Cooler Master's Silent ProM 850W power supply, 12 Cooler Master Excalibur 120mm fans, and a custom Koolance cooling system.

Harrington started on a new mod based on a Corsair Graphite Series 600T as part of a live build demo at PDXLAN 18 in July, and we're looking forward to seeing the results. He tells us that he is inspired by modders such as Bill Owen of Mnpctech.com and Richard "DarthBeavis" Surroz, and we know what he means. Seeing as how this is his second cover appearance in *CPU*, however, we'd guess he's providing a fair share of inspiration himself. ∎
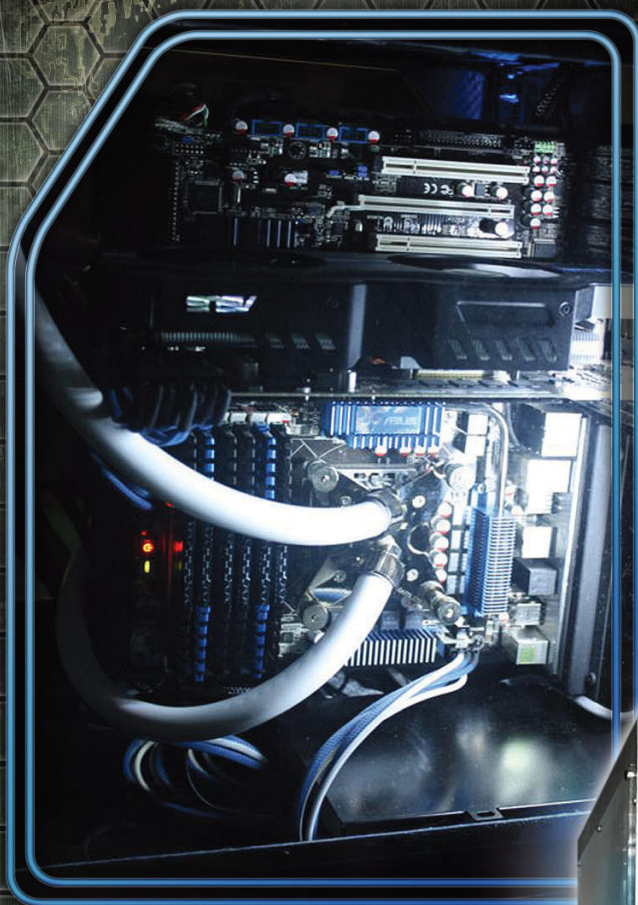
Give Us Your Mod

Have a computer mod that will bring tears to our eyes? Email photos and a description to madreadermod@cpumag.com. If we include your system in our "Mad Reader Mod" section, we'll send you $1,500 and a one-year subscription to *CPU*.

Asus ROG Formula X

Records Broken, Mods Ogled

You're probably familiar with Asus' Republic of Gamers brand; ROG graphics cards, motherboards, and notebooks have been making a name for themselves since 2006.

What you may not know is that Asus held a special ROG Formula X event on June 25 and 26 at Fry's in Sunnyvale, Calif., and *CPU* was there. Other event sponsors included Nvidia, Intel, Antec, Corsair, Cooler Master, Kingston, Patriot, and Razer.

Formula X was a combo overclocking and modding event, so not only did it have some of the coolest mods in the country on display (including this month's "Mad Reader Mod" winner), but the event was also host to 15 HWBOT records.

As if all of that wasn't enough, Asus let attendees demo the previously unreleased Super Street Fighter IV Arcade Edition and provided a demonstration on the benefits of SLI that showed two GeForce GTX 560 Tis can beat a single GTX 580, even when the 580 is overclocked using liquid nitrogen. The event also included a system-building race and a Sandy Bridge overclocking workshop.

● A number of sponsors stopped by to give attendees up-close looks at their latest products.

●● Another gorgeous day in Sunnyvale, and ROG Formula X drew a nice crowd.
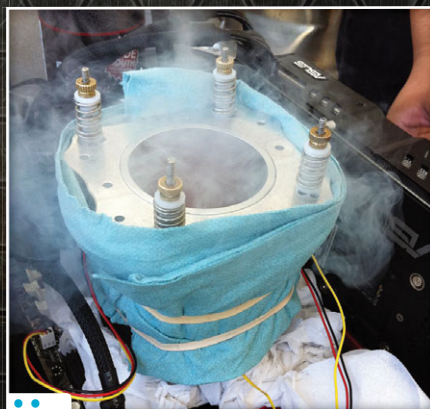
● If you want to break records, you gotta have plenty of liquid nitrogen.

●● Cooling with LN2 requires a bit of improvised insulation—and, of course, a place to put the stuff.

●●● PCJunkie209 (aka Lee Harrington, aka this month's "Mad Reader Mod" winner) had a mod in the contest and entered the OC competition, as well.

Overclocking

It was obvious from the outset that some serious overclocking was coming up, judging by the guest list and the number of enormous LN2 tanks on display. And when the dust finally settled, the results confirmed this.

Gunslinger, Gautam, V2-V3, Deux, Brian.Y, HondaCity, Planet, and Splave all achieved HWBOT records, with V2-V3 and Brian.Y racking up four each.

Diablo Azul, first-place winner.

More carbon fiber, plus Lamborghini-style "doors" and a wicked-cool paint job by Dewayne Carel of Modders-Inc.com.

All seven mod contest participants and some pretty nice swag.

Modding

Elsewhere, seven top modders (Ton Khowdee, Dewayne Carel, Richard Surroz, James Fislar, Lee Harrington, Ben Lzicar, and Charles Wang) put their wares on display. In the end, Lee "PCJunkie209" Harrington emerged victorious, but the level of skill among these modders made this a tough contest to judge—all seven mods were excellent. ■

James Fislar's aptly named Project Blood Ice HAF 922.
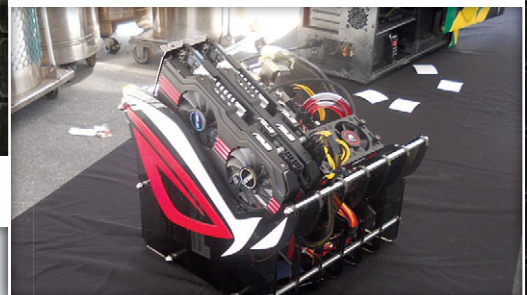
Ton Khowdee's ROG case mod, version 2.0.

Charles Wang's Red Dwarf mod: High-powered computing that fits into a carry-on.

Richard Surroz's Brimstone mod wowed the crowd.

Ben Lzicar's famous Kegputer mod was in the house at ROG Formula X, making passersby thirsty.

CPU SYSTEM WORKSHOP
ONE FOR THE CASH-STRAPPED ENTHUSIAST

I n *CPU*'s May issue, we set out to build a high-end PC capable of excelling at every enthusiast endeavor. The resulting monster, CHARLIE (Computer Honed And Ready for Leetness In Everything), had more than $3,000 worth of bleeding-edge parts crammed into a gleaming white shell, and that credit-score-poisonous price tag was only eclipsed by the system's over-the-top performance.

Building A Smarter System

CHARLIE blew us away, but when it comes to raw performance, only a few parts contribute to the scores, namely the processor, memory, storage, and graphics. So we asked ourselves, is it possible to approach CHARLIE's performance without busting the bank? By carefully selecting the components that don't suffer from the "enthusiast markup," we set out to create a great-performing system that can hang with the big dogs, but cost significantly less. Behold the Budget Boy Wonder. As you'll see, your money can go a long way.

Component Carnage

For the processor, we stepped down from CHARLIE's Intel Core i7-2600K and selected the Intel Core i5-2300 ($184.99; www.intel.com) instead. It doesn't support the K-series features that let you overclock the CPU cores and memory separately, but it is a fast 2.8GHz processor that features 6MB on Intel Smart Cache, support for dual-channel DDR3 memory, and on-die Intel HD Graphics 2000. Because BBW will rely on discrete graphics, we felt little need for Intel's more capable 3000 series graphics engine.

To cool this 95-watt processor, we discarded the stock cooler and selected the Zalman CNPS11X Extreme ($79.99; www.zalman.com). This V-shaped cooler is composed of two independent heatsinks skewered by five heatpipes. An attached 120mm fan keeps the system noise to a minimum, but Zalman threw in an optional silence-inducing resistor (RC24P).

For the foundation of our system, the Intel Z68-based Gigabyte GA-Z68XP-UD3-iSSD ($239.99; www.gigabyte.us) offers several must-have performance enhancers. For starters, there's Gigabyte's Hybrid EFI BIOS, four 6Gbps SATA ports, four USB 3.0 ports, 8-channel Realtek ALC889 codec, and support for AMD CrossFireX and Nvidia SLI. Most notably, however, is the Intel Smart Response-compatible 20GB Intel 311 SSD, which uses block-based caching to quickly launch frequently accessed applications.

($244.99; www.gigabyte.us), an overclocked GeForce GTX560 Ti. This card sports a 900MHz core clock (stock is 822MHz) and a hefty copper and aluminum heatsink, upon which are mounted a pair of WINDFORCE 2X parallel-inclined fin fans, which keep the card cool and quiet.

Our case of choice is the Corsair Carbide Series 400R (MSRP $99.99; www .corsair.com), which is a slate-gray mid-tower with a steel frame and panels. This case is spacious, clean, sturdy, and provides excellent cooling options for its meager price. We're proud of our wiring job, but Corsair's excellently designed 400R deserves most of the praise.

Think of the Enermax MAXREVO 1350W ($299.99; www.enermax.com) as a promise of things to come. It's the pinnacle of efficient power supplies, 80 PLUS Gold certified, has a five-year warranty, and is 100% modular, which made wiring the BBW surprisingly hassle-free.

Thermaltake and Cooler Master supplied the keyboard and mouse. The Thermaltake Tt eSPORTS Challenger Pro keyboard ($61.99; usa.ttesports .com) has red LED-backlit keys, swappable red WASD keys, and a tiny modular fan that cools your sweaty palms in the heat of battle. The CM Storm Spawn Mouse ($49.99; www.coolermaster-usa. com) matches our red keyboard and has a 3,500dpi optical sensor for accurate gaming and input operations, as well as seven programmable buttons.

Power User Potpourri

As you can probably tell, we're using a liberal definition of the term "budget"; however, the Budget Boy Wonder is significantly more affordable than CHARLIE, and it even has a few features that Chuck doesn't. Read on for more in-depth info on the BBW's innards and to see how this little PC performed. If you're not saving your pennies now, you will be when you're done. ∎

8GB of Kingston HyperX Genesis DDR3-1866 ($169.98; www.kingston .com) represents BBW's system memory, which should give us more than enough headroom for the enthusiast apps we have in mind. It's fast and offers low latency timings of 9-11-9-27, to ensure a snappy response to every operation.

The 240GB Kingston HyperX SSD (SH100S3/240G; $519.99; www.kingston .com) is based on the SandForce SF-2281 controller that enables sequential read/write throughputs of 555 to 510MBps.

For BBW's graphics adapter, our more reality-grounded selection comes in the form of Gigabyte's GV-N560OC-1GI

BY ANDREW LEIBMAN

GIGABYTE Z68XP-UD3-iSSD

GIGABYTE's Z68XP-UD3-iSSD motherboard is built to easily take advantage of the Intel SRT (Smart Response Technology) found on the Z68 chipset. First off, the motherboard is bundled with a 20GB Intel SSD (311 Series), and GIGABYTE includes its EZ Smart Response utility to automatically set up your PC for use with SRT. Thus, there's no need to buy an SSD, enter the BIOS to configure the RAID, reinstall the operating system, install the Intel Rapid Storage utility, or manually configure Intel's SRT.

WHAT IS INTEL SMART RESPONSE TECHNOLOGY?

SRT is designed to use a small portion of SSD storage (up to 64GB) as a quick access cache for the data you access the most. Thus, you'll be able to speed up the loading times and file recall for the applications and data you use the most often. It's also an ideal feature for systems where the OS is installed onto an HDD, because you'll be able to enjoy the speedy retrieval benefits of SSD storage without giving up the large capacity of traditional hard drives.

MOTHERBOARD FEATURES

For high-speed data transfer, GIGABYTE includes two 6Gbps SATA connectors and four USB 3.0 ports (two on the back panel and two via the board's internal header). There's also support for 3TB HDDs via GIGABYTE's DualBIOS 3TB+, which combines the failover capability of two physical BIOS with 3TB hard drive booting (without the need for partitioning). An HDMI 1.4 video output, combined with the InTru 3D capability of the Intel graphics processor, gives you the capability to enjoy 3D Blu-ray playback at 1080p quality.

The Z68XP-UD3-iSSD also offers Lucid-Logix Virtu GPU Virtualization, which lets
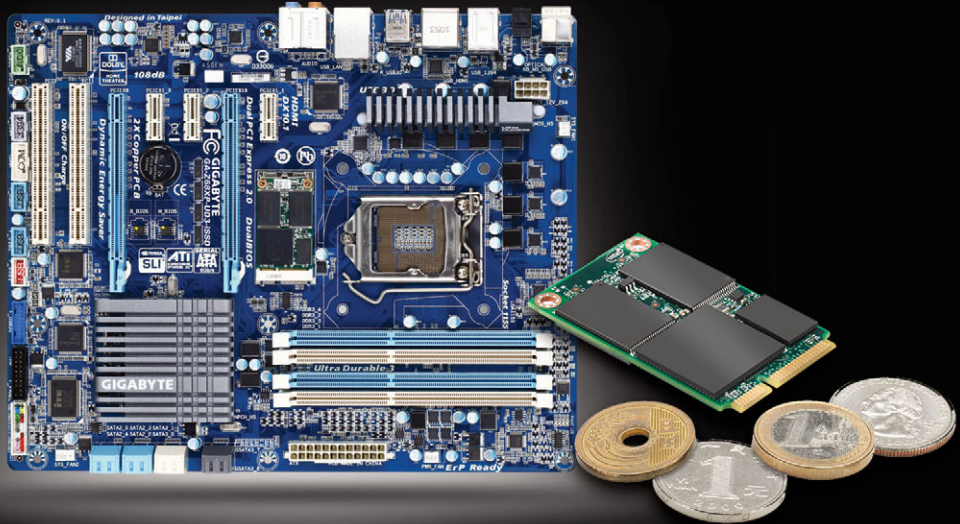
INTEL® SOLID-STATE DRIVE 311 SERIES M-SATA

you switch between the Intel integrated graphics and a discrete graphics card. You can reduce power consumption by selecting the integrated graphics when performing non-demanding tasks, and move over to the discrete graphics card when gaming or editing multimedia. The board supports both CrossFireX and SLI graphics configurations, and audiophiles will appreciate the inclusion of Dolby Home Theater and support for 7.1-channel surround-sound configurations. ■

Z68XP-UD3-iSSD
$239.99
GIGABYTE
www.gigabyte.us
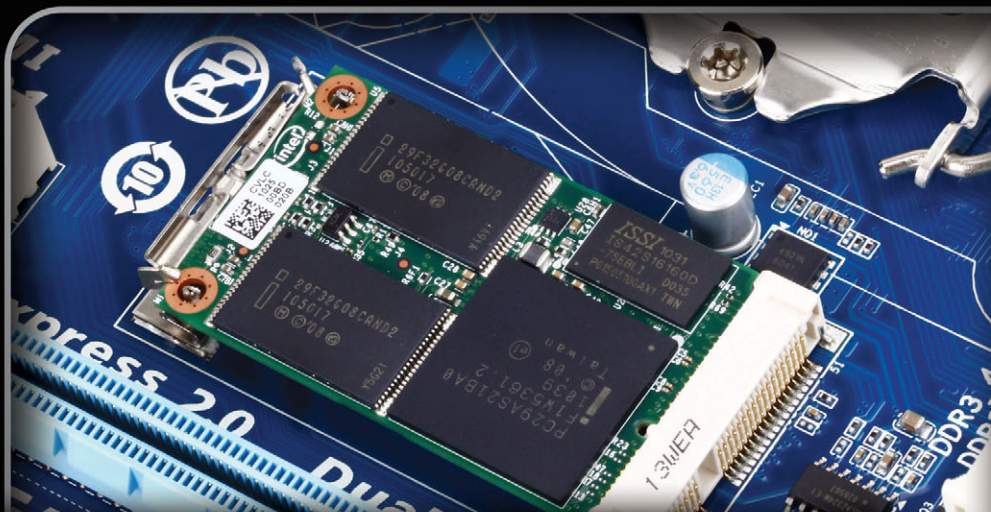
SPECS: Socket LGA 1155; Intel Z68 chipset; Max memory: 32GB DDR3-2133 (OC); Expansion slots: two PCI-E x16 (one slot runs at x8; if both slots are populated, both run at x8), three PCI-E x1, two PCI; Ports: two 6Gbps SATA, four 3Gbps SATA, four USB 3.0, 14 USB 2.0, two FireWire, one Gigabit Ethernet.

CORSAIR
CARBIDE SERIES 400R

Not all system builders want their cases to be loud and attention-grabbing. Some prefer simple but stylish towers that get the job done without all the bling and over-the-top aesthetics. If this describes you, Corsair's Carbide Series 400R is the case you're looking for. Plus it has a multitude of customizable cooling options, room for expansion, tool-less side panels and drive bays, and much more.

The 400R is pretty on the outside, but its true beauty is on the inside, which is roomy and packed with features designed with you in mind, including space for an ATX or mATX motherboard, lots of hard drives and SSDs, as many as eight expansion cards up to 316mm long, and plenty of fans. The motherboard tray and right side panel are optimized for excellent cable management,

which in turn leads to better interior airflow and a clean, clutter-free look.

Speaking of airflow and cooling, Corsair includes two front 120mm fans and one rear 120mm fan with the 400R, and you can add as many as seven more fans as needed, thanks to its six 120mm/140mm fan mounts and four 120mm fan mounts. The spacious top panel also gives you the option of mounting a 240mm radiator for custom watercooling setups or Corsair's Hydro Series H100.

The 400R is functional, solid, and attractive, but it's also technically advanced: Its front panel sports two USB 3.0 ports, and its six 3.5-inch drive bays are built to accommodate 2.5-inch SSDs, as well. In other words, it's ready for anything you can throw at it, now and for years to come. ■

Carbide Series 400R
MSRP $99
Corsair
www.corsair.com

SPECS: Dimensions: 20.5 x 8.1 x 19.8 (HxWxD); Motherboard support: ATX, mATX; Bays: 4 x 5.25-inch drive bays, 6 x 3.5-inch/2.5-inch drive caddies; Fans: 2 x 120mm front, 1 x 120mm rear, 4 x 120mm mounts, 6 total 120mm/140mm mounts; Ports: 2 USB 3.0, 1 IEEE1394, audio I/O

KINGSTON HYPERX KHX1866C9D3K2/4GX

You have to hit a certain trifecta if you want to build a stable PC. The motherboard, obviously, has to comprise quality components. The power supply's output must be clean and reliable. And the memory you choose must be trustworthy with your data.

Kingston Technology has proven that last point over and over again. As JEDEC memory standards have evolved, so has the company's product lineup. We're fans of Kingston's HyperX family of enthusiast DIMMs, and the kit we picked for our Budget Benchmark Buster build was so nice, we bought it twice. Snapped into place in our case are two sets of 4GB (2 x 2GB) DDR3, for a grand total of 8GB in four DIMMs. Oh, and their heat spreaders went well with our Gigabyte motherboard.

The Kingston quartet ran fine at its default settings of 1,333MTps at 1.5V with timings of CL9-9-9. One of its XMP (Extreme Memory Profile) overclocking profiles would have taken it up to 1,600MTps and CL9-9-9-27 at a voltage level of 1.65V.

However, boys being boys, we cranked the proverbial performance knob to XMP Profile #1. This loosened the timings to CL9-11-9-27 in order to push the megatransfer rate up to 1,866MTps.
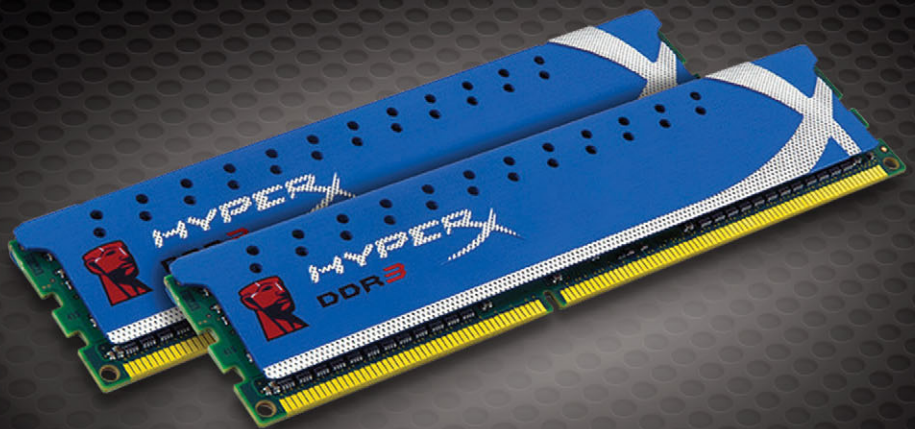
Surprisingly for a four-pack of memory modules, the Kingstons took these overclocked settings in stride. We've seen other brands ride the ragged edge with just a pair of DIMMs when we've floored the XMP pedal, so it's encouraging to us that these HyperX kits are capable of doing what they say on the box.

All throughout our testing sessions, the Kingston DDR3 handled everything sent its way. We encountered no errors attributable to the memory, even when our benchmarks challenged our budget build to stand up and be counted.

It's worth remembering that the RAM has a bearing on everything your PC does. Stick with a proven model from a proven brand, and you'll forestall a lot of avoidable headaches. ■

HyperX KHX1866C9D3K2/4GX
$84.99
Kingston
www.kingston.com

SPECS: Capacity: 8GB (4 x 2GB); Speed: PC3-14900 (1,866MHz); Timings: CL9-11-9-27; Voltage: 1.5V; Warranty: Limited lifetime

KINGSTON HYPERX SSD (240GB)

Kingston's 240GB HyperX SSD features a second-generation SandForce controller with 6Gbps SATA capability that allows Kingston to deliver an exceptionally fast sequential read speed of 555MBps and a sequential write speed of 510MBps.

Kingston built the HyperX SSDs using Intel's 25nm Compute NAND, which features a 5K erasure cycle that provides improved endurance over models that use a standard 3K cycle. The HyperX SSDs also include wear-leveling technology, which is an algorithm that helps to ensure that individual flash memory blocks are used at the balanced rate that will not exceed a 2% difference between the most often and least written blocks. The result of the wear-leveling is that you'll enjoy the benefits of both improved life span and optimal performance.

The SandForce controller allows the HyperX SSDs to use DuraClass NAND flash management, which includes tools for flash media error correction protection against the reprogramming of cells during read and program cycles; and intelligent garbage collection that focuses on having the least impact on endurance. DuraWrite is a key utility of DuraClass management designed to optimize the number of program cycles with the flash memory.

With Kingston's HyperX SSDs, you'll enjoy TRIM support that speeds up write performance by letting your OS notify the SSD which data blocks are available to be written to. There's also S.M.A.R.T. support to keep track of bad blocks and remap the data so that it's written to a known good block. Power users and gamers will also like that the 240GB HyperX SSD allows users to tweak the SSD to meet their performance needs. For instance, you can increase the size of the over-provisioned spare area, which will reduce the overall capacity to increase speed and overall performance.

Kingston offers the 240GB HyperX SSD on its own or as a HyperX Upgrade Kit. The bundle includes Acronis True Image HD migration software, a HyperX 2.5-inch to 3.5-inch mounting plate, a USB external drive bay, a multi-head screwdriver, and SATA data cable. ■

HyperX SSD
$519.99 ($539.99 w/Upgrade Kit)
Kingston
www.kingston.com

SPECS: Sequential data transfer ratings: 555MBps read, 510MBps write; Sequential 4KB transfer ratings: 40,000/60,000 IOPS; Form factor: 2.5-inch; Power consumption (typical): 0.4555W idle, 1.5W read, 2.05W write; Shock tolerance: 1,500G; Warranty: 3-year

ENERMAX MAXREVO 1350W

You don't drop a PSU that obliterates the 1,000W barrier into a case unless you mean to do serious business, the type that relies on multiple GPUs capable of sucking down 200-plus watts each along with a multitasking, multicore CPU that consumes roughly 100 more watts when running full tilt. You sure don't go to such power-supplying lengths unless you're certain the power reaching those components is high-quality juice that's clean and reliable. Enter the highly praised, award-winning Enermax MaxRevo 1350W (EMR1350EWT), a fully modular powder keg that delivers maximum wattage, reliability, and efficiency to high-end gaming systems, servers, workstations, or other power-hungry configurations.

Featuring six 12V rails each outputting up to 30A for 112A total DC power and 3.3V and 5V rails each supplying up to 25A (140W combined), the C6-, SLI-, and Crossfire-ready MaxRevo 1350W pushes that power using Copper-Bridge Array transmission technology in lieu of traditional wires. The approach results in a 4X wider and shorter transmission path that results in up to 3% improved regulation, meaning cleaner, more reliable DC output for pricey high-end systems.

Further aiding the MaxRevo 1350W's stability and overall stellar performance—up to 94% peak efficiency; 80Plus Gold Standard certification and only 1% shy from Platinum rating—is the use of Enermax's FMQ (Full-Zone Magnetic Quadrant) transformer design, which enables maximum switching efficiency with minimized current loss. Additionally, the 1350W implements 100% 105-degree Celsius Japanese electrolytic capacitors and an Enermax 139mm fan featuring patented magnetic ball-based Twister Bearing technology (100,000 hours MTBF) for frictionless operation that greatly reduces noise. An integrated CordGuard mechanism, meanwhile, locks the 1350W's AC power cord in place to prevent unintentional shutdowns, while HeatGuard protection keeps the fan spinning up to a minute after shutdown to usher remaining heat from the chassis.

Wrapped in a scratch-resistant, powder-coated exterior, the 1350W's honeycombed rear mesh enhances the PSU's airflow, while its modular design makes connecting and routing cables a manageable, flexible task. An extensive package of included long, sheaved cables, meanwhile, covers the most demanding connector requirements (eight 6+2-pin PCI-E, 14 SATA, 10 Molex, etc.). Add everything up, and the 1350W is a seriously powerful PSU for serious computing needs. ■

MaxRevo 1350W
$299.99
Enermax
www.enermax.com

COOLER MASTER CM STORM SPAWN

The first thing you're likely to notice when sizing up the CM Storm Spawn is its sleek profile and its bold red outer shell. Next, you'll notice its seven strategically placed buttons. Finished with anti-slip coating, the rubberized left and right buttons enable precise clicks, helping you stay on the mark even under the hottest, most frenzied conditions.

Need to step lightly and get the lay of the land before making your next move? The Spawn's scroll wheel incorporates a precise stepping encoder. The arrow buttons situated behind the scroll wheel let you adjust DPI on the fly; you can quickly choose the mouse's 800, 1,800, or 3,500dpi setting, ensuring that you have the control you need without ever having to leave the game or open a menu. The Spawn has other design strengths, as well, including an anti-drift control sensor for greater accuracy, rubberized side grips, and Omron micro switches rated at up to 5 million clicks.

CM Storm's downloadable software provides a control panel that makes it easy to set up button assignments, adjust click and scroll speeds, and record new macros. You can also adjust the DPI and pointer speed in the Custom tab. The best part, though, is that the Spawn is equipped with an onboard Sentinel-X 32KB processor that lets you store your personal configs on the mouse—no matter where you take the Spawn or what PC you plug it into, it knows what you want and delivers.

In other words, the Spawn isn't just another pretty gaming mouse: It's also intelligent, rugged, and utterly dependable. ■

CM Storm Spawn
$49.99
Cooler Master
www.coolermaster-usa.com

SPECS: Dimensions: 4.3 x 3 x 1.3 inches (HxWxD); Material: Rubber grip/ABS plastic; Sensor: 3,500dpi Storm tactical optical sensor; Speed measurement: 6,400fps; Maximum tracking speed: 60ips

THE BUDGET BOY WONDER
GOING FOR BROKE

The Budget Boy Wonder took to the benchmarks like a processor's heat spreader to thermal grease. Although a single GeForce GTX 560 Ti can't compete with a pair of GTX 580s in SLI, it did deliver better than 30 frames per second in our demanding DX11 games and posted some impressive numbers in 3DMark 11. Since testing CHARLIE, we retired PCMark Vantage in favor of PCMark 7, and here, too, the BBW zipped through the general computing workloads. The SSD, memory, and quad-core Sandy Bridge chip are largely to thank. The difference between a quad-core with Hyper Threading and one without becomes wildly apparent In Sandra 2011 and Cinebench 11.5; scores were about 20 to 40% lower than CHARLIE's Intel Core i7-2600K managed.

To really push this system to its limits, we overclocked the processor from 2.8GHz to 3.2GHz using the multiplier, fully aware that we were also stressing the rest of the system by doing so. We enabled an XMP profile that raised our Kingston HyperX memory frequency to its rated 1,866MHz. We also cranked up the core and memory clock of the Gigabyte GeForce GTX 560 Ti to 950MHz and 1,100MHz, respectively.

Although those clocks weren't stable in Unigine Heaven, AvP and S.T.A.L.K.E.R. yielded slightly better frame rates, and the card remained quiet throughout. We achieved some of our biggest gains in the CPU-centric tests, including Sandra's Media Transcode and POV-Ray.

At the end of the day, it's clear that when it comes to PC parts, sadly, money does matter. But we've proven that even a realistic budget can get you enthusiast-level performance, a supremely quiet computing experience, ultra-fast boot times, a slick-looking system, and even a little bling. ∎

BY ANDREW LEIBMAN

Benchmark Results	Budget Boy Wonder	Budget Boy Wonder Overclocked
3DMark 11 Performance		
3DMark Overall	P4592	P4905
Graphics Score	4424	4699
Physics Score	5653	6380
Combined Score	4611	4823
Graphics Test 1	21.25fps	22.55fps
Graphics Test 2	20.83fps	22.13fps
Graphics Test 3	26.67fps	28.57fps
Graphics Test 4	13.27fps	14.04fps
Physics Test	17.95fps	20.26fps
Combined Test	21.45fps	22.43fps
PCMark 7		
PCMark Score	4401	4610
Productivity Score	4116	4358
Creativity Score	4431	4618
Entertainment Score	4476	4747
Computation Score	3551	3857
System Storage Score	4739	4761
SiSoft Sandra 2011 Lite		
Processor Arithmetic		
Dhrystone iSSE4.2 (GIPS)	88	97.23
Whetstone iSSE3 (GFLOPS)	41.84	45
Processor Multi-Media		
x16 iSSE4.1 (Mpixels/s)	134.46	147.6
x8 iSSE2 (Mpixels/s)	92	101.33
x4 iSSE2 (Mpixels/s)	49.37	54.8
Memory Bandwidth		
Integer Buffered iSSE2 (GBps)	17.37	24.18
Floating-Point Buffered iSSE2 (GBps)	17.35	24.14
Media Transcode		
Transcode WMV (KBps)	698	780
Transcode H264 (KBps)	688	769
Cinebench 11.5		
CPU***	4.63	5.05
POV-Ray 3.7 Beta**	838.47	926.05
CrystalDiskMark 3.0.1 (MBps)		
Sequential Read	259	250.6
Sequential Write	201	206.3
512KB Random Read	249.3	244.5
512KB Random Write	198.2	203.7
4KB Random Read QD1	26.5	26.62
4KB Random Write QD1	45.81	46.41
4KB Random Read QD32	21.41	21.24
4KB Random Write QD32	57.1	71.16
Unigine Heaven 2.5		
FPS	24.5fps	N/A
Score	618	N/A
Aliens vs. Predator (4xAA, 16xAF)	31fps	33fps
S.T.A.L.K.E.R.: CoP (4xAA)	33.5fps	33.6fps

* minutes: seconds
** pixels per second
*** points
Games tested at 1,920 x 1,200
Specs: Processor: Intel Core i5-2300 (2.8GHz, quad-core); CPU Cooler: Zalman CNPS11X Extreme; Motherboard: Gigabyte GA-Z68XP-UD3-iSSD;
Graphics: Gigabyte GV-N560OC-1GI; RAM: 16GB Kingston HyperX Genesis DDR3-1866; Boot drive: 240GB Kingston HyperX SSD; PSU: Enermax
MAXREVO 1350W; Case: Corsair Carbide Series 400R

Get informed answers to your advanced technical questions from *CPU*. Send your questions along with a phone and/or fax number, so we can call you if necessary, to q&a@cpumag.com. Please include all pertinent system information.

Each month we dig deep into the CPU *mailbag in an effort to answer your most pressing technical questions. Want some advice on your next purchase or upgrade? Have a ghost in your machine? Are BSODs making your life miserable? CPU's "Advanced Q&A Corner" is here for you.*

Mike J. asked: I have a workstation built around an Evga Classified SR-2, dual-socket motherboard, with a pair of Xeons, 24GB of RAM, and two GeForce GTX 580 cards running in SLI. I wanted to upgrade the system with a set of 6Gbps SATA solid-state drives running in RAID 0, but my motherboard doesn't really support this kind of setup. I can do RAID 0 on the Intel controller, but only at 3Gbps SATA speeds. I can connect the SSDs to an integrated Marvell controller that supports 6Gbps SATA, but it's connected to the chipset using only one PCI-E x1 lane, so it's limited to 500MBps transfers, which a pair of fast SSDs can obliterate.

Harnessing the full power of two ultra-fast 6Gbps in RAID 0 often requires a creative approach, such as using an add-in card. Even then, more out-of-the-ordinary tactics may also be necessary.

I decided to add an LSI hardware RAID card with the SSDs, but I can't open the RAID card's BIOS to configure the drives. I did some research after the fact, and, apparently, this motherboard doesn't have enough "option ROM" space to support the RAID card. LSI's technical support won't give me any help because they said the card is only certified to work on servers. Any thoughts on what I can do without ripping up my system?

A: There are a couple of things you can do, Mike. This is a problem that comes up from time to time with motherboards that don't have enough option ROM space to load the RAID card's BIOS configuration menus. Depending on the option ROM space requirements of your particular RAID controller, you may be able to work around the issue by disabling your motherboard's integrated Marvell (and JMicron if you're not using it)

controller in the board's system BIOS and then trying to access your LSI card's BIOS.

Assuming you'll have other drives in your system for bulk storage, another workaround is to use your RAID controller's Windows-based (or Linux-based) configuration utility to set up the SSDs. You'll have to sacrifice a bit of space on a secondary drive for an OS installation, but you'll be able to boot into that OS and configure the RAID card from there, then simply change the boot order in your system BIOS and install an OS on the SSD RAID volume. The downside to this method is that you won't have as much free storage space available, but a big plus is that you'll have a secondary OS install at the ready should a problem ever arise with the RAID array. The benefits to this kind of setup far outweighs the disadvantages, though, in our opinion. Having that second OS installation available can be a real godsend in the event of a problem.
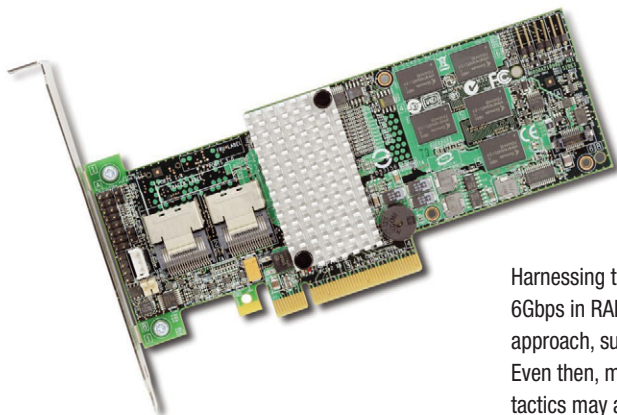
John I. asked: I just upgraded my Internet service to a connection that's supposed to be capable of 50Mbps downstream and 8Mbps upstream, but I haven't noticed one bit of difference in performance. If I go to a speed test Web site and gauge performance, my connection is hitting (and sometimes exceeding) its advertised speeds, but browsing speed doesn't seem affected at all. Is there something I need to do to my PC and the other systems in the house to make sure I'm taking advantage of the faster connection?

A: John, if your connection speed tests are indicating the proper upload and download speeds, odds are you're bottlenecked by something else that makes it seem as if your new connection isn't as fast as it's supposed to be. Keep in mind that there are multiple bottlenecks when browsing the Web, such as the speed of your ISP's DNS servers or even the bandwidth available to the sites you're browsing.

Assuming that your machine is free from malware and that you're using a modern browser, using fast public DNS servers can have a huge impact on browsing speed. When you first type in a Web address or click a link, the DNS server you're using must look up that site's IP address. If there is any lag or delay in this step, you end up having to wait a bit before your browser ever actually hits the page and starts downloading data. That delay makes it seem like your connection is slow.

We like Google Public DNS (code .google.com/speed/public-dns/) or OpenDNS (www.opendns.com), but there are others out there. Do a search for the fastest public DNS servers in your area and try using those.

Even with the fastest connection and DNS servers available, you may also be limited by the speed of the sites you're connecting to. If you have a 50Mbps pipe, but the server you're hitting is under a heavy load and can only trickle out data, that fast connection isn't going to help you one bit.

If your machines have a working Internet connection, just ensure they're not infected with any malware, keep their NIC drivers up-to-date, and check that all of their physical connections are in good shape.

Josh T. asked: I'm looking into expanding my system's memory footprint a bit since I do quite a bit of work with video editing. I'm currently running a Core i7 machine with Windows 7 Ultimate x64 and have 6GB of DDR3-1333 installed but would like to pick up a 12GB kit since RAM is relatively cheap right now. I may never use that much memory space, but with some of the large multi-GB video files I work

Some high-end DDR3-2000 memory might be tempting, but if you're looking to upgrade to 12GB of memory, save your money and go with a DDR3-1600 or 1333 kit. You'll see minimal if any gains for blistering clock speeds in a tri-channel setup.

with in Sony Vegas and other programs, it might help a bit. Regardless, my question is, is it worth it to spring for a higher-speed kit like a DDR3-1600 or DDR3-2000 kit? I'm looking at kits from Corsair, Crucial, and G.Skill, and as you get up to the 2GHz mark, pricing can actually double. Though RAM is still dirt cheap, relatively speaking, is it worth it?

A: First, we'd offer that there are few users who will actually realize the benefit of going to 12GB of system memory from a 6GB

> Only hardcore overclockers and performance enthusiasts who want flexibility to run their RAM at a wide range of clock speeds will see a benefit from going with a 2GHz tri-channel kit.

installation. However, with memory, like storage, it seems like you can never have too much of a good thing. From what you've described above, we'll assume you're running an Intel Core i7-based system with an X58 chipset and a triple-channel kit. There's one thing for sure with a triple-channel memory kit: You already have a ton of memory bandwidth at your disposal.

Over the years, we've had the opportunity to test and tweak memory speeds on many an X58 board, and there is definitely a point of diminishing returns when it comes to memory clock speeds. In fact, for a tri-channel setup, once you get up above the 1,600MHz range, latency and timings can affect memory bandwidth much more so than clock speed. Performance-wise, even Intel's six-core Core i7 chips will show negligible gains above 1,600MHz or so in a tri-channel X58 setup, and the downside of possible stability issues that can arise really isn't worth it. Only hardcore overclockers and performance enthusiasts who want flexibility to run their RAM at a wide range of clock speeds will see a benefit from going with a 2GHz tri-channel kit.

And the cost delta for these premium kits, as you noted, is another reason not to belly up. Our recommendation is to save your money and go with a brand-name DDR3-1333 or 1600 kit from any of the short list of manufacturers you mentioned. In fact, look at timings rather than clock speed and go with a lower-latency kit if pricing is similar. You're likely to have fewer headaches with kits that can work across tight or relaxed timings. ■

BY Dave Altavilla and Marco Chiappetta, the experts over at HotHardware.com.

All-In-One GPU Liquid Cooling
Asetek & PNY Join Forces For Cool Graphics

As technologies begin to mature, manufacturers often begin combining them into "all-in-one" devices, providing more value and features.

For example, people used to buy fax machines and scanners separately. Now you can get both combined with a pretty good printer for about what you'll pay for the ink. It just makes things easier for the consumer.

Now, all-in-one capabilities have made their way into the liquid-cooled graphics card market, thanks to PNY Technologies'

recently announced GeForce Liquid Cooled Series graphics cards, part of PNY's XLR8 lineup with built-in liquid cooling by Asetek. The first card released in the series is a GTX 580 designed to increase performance and reduce noise and temperature while remaining easy to install, providing a ready-made option for cooling the GPU.

"The card installs just like an air-cooled graphics card," says Stu Grubbs of Asetek. "Installing the radiator is as easy as installing a chassis fan, and you're done."

Liquid-Cooled Options

PNY is initially offering two cards as part of its GeForce Liquid Cooled Series– the previously mentioned GTX 580 (with an MSRP of $579.99) and a second GTX 580 that offers both GPU and CPU cooling ($649.99).

"Previously, installing liquid cooling on graphics cards has meant voiding your warranty," Grubbs says. "With this offering, PNY hands you a five-year warranty and liquid cooling for

Liquid-Cooling Components

Five primary components make up the all-in-one GPU cooling solution from Asetek and PNY. The components should be familiar, as many of them are identical to those found in CPU liquid-cooling systems.

Pump. The pump is probably the key component to the GPU liquid-cooling system. It moves the cooling liquid through the system, and the speed with which the pump moves the liquid helps determine the efficiency of the cooling process.

Cold Plate. The cold plate causes a more efficient transfer of heat from the GPU into the liquid inside the pump.

Heat Exchanger. The heat exchanger is simply a radiator. The heat from the liquid is drawn into the radiator fins as the liquid moves through the radiator. Moving air contacts the fins, absorbing the heat from the fins and carrying it out of the PC.

Liquid Tubes. The liquid tubes carry the hot cooling liquid from the pump to the heat exchanger, and cool liquid back to the pump.

Cooling Liquid. To prevent contaminants, many systems make use of distilled water as the cooling liquid in the system. Asetek adds anti-corrosion and anti-bacterial packages to the liquid. The cooling liquid is completely sealed inside the cooling system, meaning it cannot leak into the electronics of the graphics card or the computing system.

All of these items combine to form the XLR8 GTX 580 Liquid Cooled Graphics Card (photo A) and the XLR8 GTX 580 Liquid Cooled Graphics Card with CPU Cooling (photo B), both of which are built by Asetek and sold by PNY.

Sources: Asetek, PNY

Pump

Cold Plate

Heat Exchanger

Liquid Tubes

A

B

as little as $100 over the price of the graphics card you were already planning to buy."

PNY and Asetek demonstrated the GTX 580 Liquid Cooled Series at E3 in Los Angeles and at the CEA Line Show in New York City, both in June.

The Technology

The technology in the Liquid Cooled Series cards closely resembles one of the closed-loop liquid-cooling systems that have become so popular for CPU cooling lately. Many of the components and the overall cooling process are similar; Grubbs says it made sense for Asetek to build on an already successful technology.

"Having shipped over half a million CPU liquid coolers, we know this technology is robust, reliable, affordable, and delivers great performance," Grubbs says.

Even though the overall systems look similar, Asetek made some precise adjustments to the system to accommodate GPU liquid cooling.

"A GPU has a very different heat map vs. a CPU," Grubbs says. "A CPU generates the majority of its heat toward the center of the chip, whereas a GPU is not only a larger chip, but the heat is more spread out."

Additionally, because the graphics card is in a different location inside a PC case than the CPU, Asetek had to make some changes to its cold plate design and tubing for the GPU cooler to allow for the proper placement of the heat exchanger.

Cooling The Market

Building an all-in-one liquid cooling and graphics card solution offers plenty of benefits for the enthusiast and gaming markets.

Overclocking. With liquid cooling, Asetek enables PNY to push the limits of their GTX 580 lineup.

"When you pull a liquid-cooled PNY graphics card out of the box, you will be holding the fastest factory-overclocked card on the market at 857MHz," Grubbs says.

Size. During the creation of the GPU cooler, Asetek's designers made sure the graphics card only requires two PCI slots, even with the liquid-cooling system attached.

"Many after-market air coolers for graphics cards are so bulky that they actually cause the card to take up a total of three or four PCI slots when installed," Grubbs says. "It was important that our solution only take up the same amount of space as the original card."

Power. Because the XLR8 liquid-cooling system pulls power directly from the graphics card, it was important to design the cooler to use as little power as possible—between 3 and 5 watts.

Noise. Using liquid cooling rather than air cooling immediately gives the XLR8 cards an advantage over other GPU cooling solutions, says Grubbs.

"Graphics cards are notoriously loud; it is irritating. With our liquid-cooling solution, we run over 30 decibels quieter than an air-cooling solution," he says. "This is an enormous difference. Whisper quiet graphics are a beautiful thing."

Keeping Cool

Grubbs tells us that Asetek will continue working with partner companies to offer all-in-one GPU liquid-cooling solutions, and he expects such options to grow in popularity in future years.

"Having been around as long as we have, every part of our history plays a role in our future engineering," he says. "Next, I'd expect standardization of mounting mechanisms will likely expand to a larger mix of graphics cards, which will make liquid cooling available on a broader range of cards." ■

BY KYLE SCHURMAN

Liquid Cooling In Action

Here's how the GPU liquid-cooling system works.

1. When the GPU begins generating heat, the cold plate begins transferring that heat into the cooling liquid inside the pump.
2. The pump then pushes the warm liquid through the tube to the heat exchanger (as shown by yellow dots in the upper tube).
3. Air movement created by the chassis fan moves across the fins of the heat exchanger. The cool air (blue bars) heats up as it moves through the heat exchanger (yellow bars), carrying the heat outside the chassis.
4. Once the liquid has cooled again (as shown by blue dots in the lower tube), it moves out of the heat exchanger, through another tube, and re-enters the pump.
5. If the GPU's heat generation levels increase (shown in red in the pump), the fan speed can increase, pulling more cool air through the heat exchanger.

Sources: Asetek, PNY
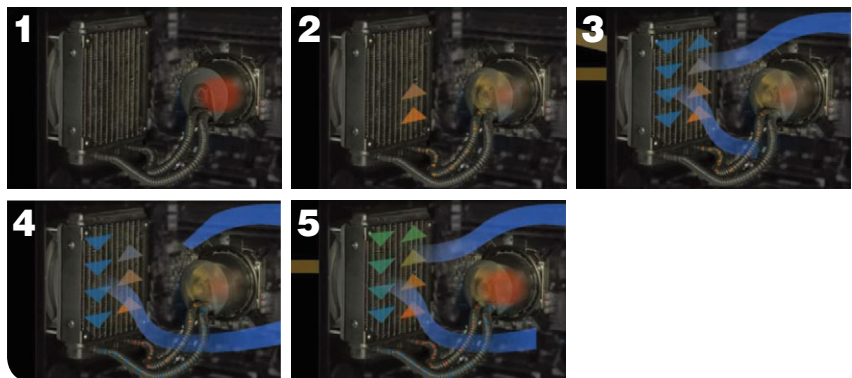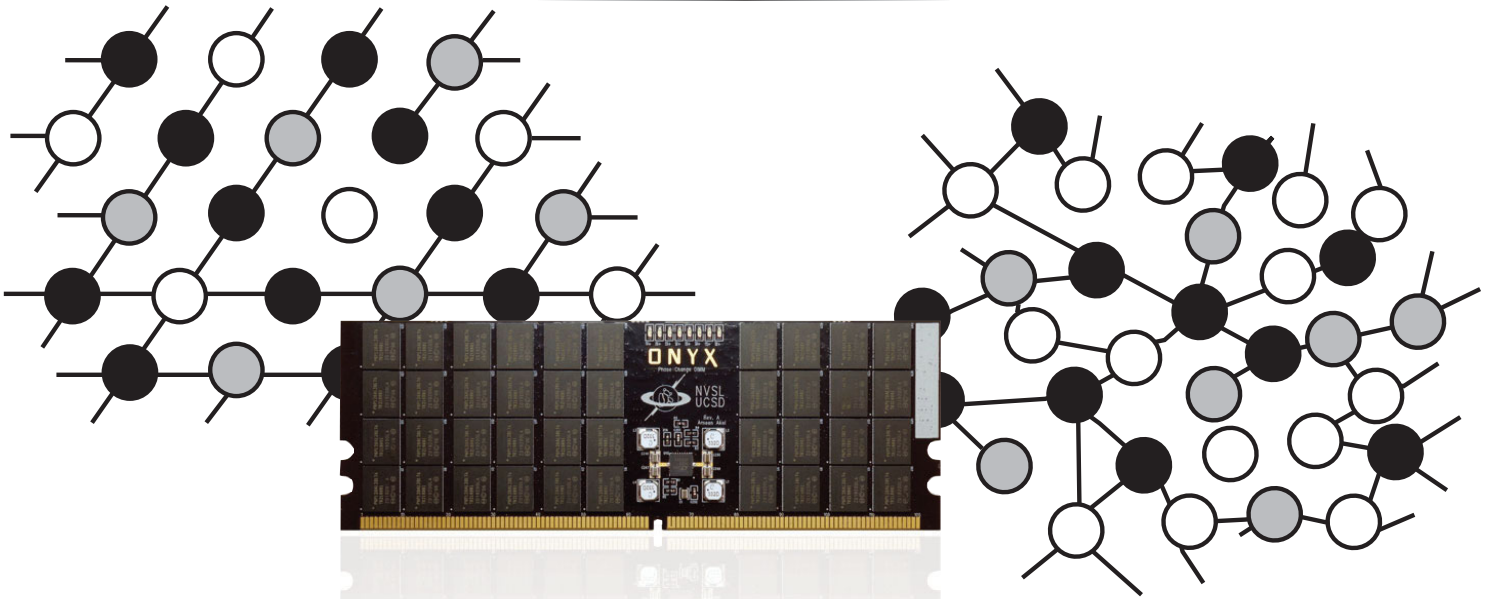
Phase-Change Memory Goes Long

Research Project Shows Viability Of PCM In SSDs

Traditional magnetic hard disk drive storage technology has served computer users well for a few decades. Hard drives have greatly increased in storage capacity and density while decreasing in cost over the years.

Still, the magnetic recording technology used in hard drives has some limitations, especially in terms of data access speeds, at least when compared to other types of storage technologies. Magnetic hard drives are by nature physically larger than some other types of storage technologies, as well, and are susceptible to breakdowns because they have several moving parts, including delicate read-write heads.

To alleviate such problems and to meet the changing needs of data storage as driven by Web-based applications, fast memory solutions with no moving parts may be the choice of the future for storage drives. For example, flash memory-equipped solid-state drives offer some improvements vs. hard drives, and flash memory is being used as the primary storage technology in an increasing number of products. SSDs make use of non-volatile memory chips to store the data. They offer faster access times than hard drives and have no moving parts.

According to researchers at the University of California, San Diego, another type of non-volatile memory data storage technology—phase-change memory, or PCM—has the potential to provide even more improvements. A recently announced project called Onyx, which used first-generation phase-change memory devices, revealed some of the progress the UC San Diego researchers have made.

Phase-Change Memory

Basic phase-change memory technology makes use of PCM chips that store data in a material that changes phases when tiny, but intense, bursts of heat are applied.

"Phase-change memory enables very fast random access because, like flash memory, there is no physical movement involved with accessing data on the device," says Adrian Caulfield, a graduate student at UC San Diego, who was one of the graduate students leading the Onyx research project.

With phase-change memory, the atoms form an ordered crystal lattice in one phase but have a disorganized look in the other phase. The organization of the atoms determines the data stored in each bit.

Phase-change chips can rewrite over previously stored bits by simply applying the burst of heat again and rearranging the atoms. Flash memory in solid-state drives must erase bits in an entire large segment at one time, which is one of the reasons they work more slowly than phase-change chips. Therefore, PCM can avoid the latency problems that can sometimes plague flash memory, especially for read

and write operations involving small amounts of data.

UC San Diego's Research

The Onyx team, led by UC San Diego professor Steven Swanson, built a 10GB prototype drive based on phase-change memory that consisted of 8GB of useable storage space and 2GB of storage for error correction. During testing, the researchers compared the performance of the phase-change drive to an 80GB commercial flash drive that was designed for use in servers.

Notable testing results included the following:

• When writing small chunks of data (less than 2KB), the phase-change drive was faster than the flash drive by 72 to 120%.

Onyx's Configuration

When connecting Onyx to a computing system, the researchers used an eight-lane PCIe 1.1 interface connection, which provides a 2GBps full-duplex connection (equaling 4GBps total bandwidth).

To minimize software overheads, the researchers used a block driver with Onyx, through which applications can access the PCM drive.

The PCM device's controller—what the UC San Diego researchers call the "brain"—handles scheduling and communications, as well as tracking outstanding accesses. The communication between the controller and the eight 1.25GB banks of PCM memory occurs through a ring network. (In the illustration, each PCM bank is listed as 1GB because each bank contains 8 bytes of useable storage space and 2 bytes of error correction, meaning 1GB of each bank is useable storage space and 0.25GB is required for error correction.)

As requests are made, the system provides unique tags for each request, and the system can handle up to 64 unique requests simultaneously.

When performing a read, the controller places the PCM banks into a "read array" mode, and it then can load the read data into Onyx's internal buffer. A 16-byte read would take 314 nanoseconds to complete.

When performing a write operation, the controller fills the PCM bank's internal write buffer before beginning the write process. A 64-byte write would take about 120,000 nanoseconds (or 120 microseconds) to complete.

Onyx is organized into PCM DIMMs, each of which contains 40 PCM chips (as shown in the photo). Each chip has 16MB of storage, meaning each PCM DIMM offers 640MB of storage space (with 512MB devoted to storage and 128MB devoted to error correction).

With Onyx, each of the eight PCM memory controllers handles two PCM DIMMs, meaning Onyx uses a total of 16 PCM DIMMs.
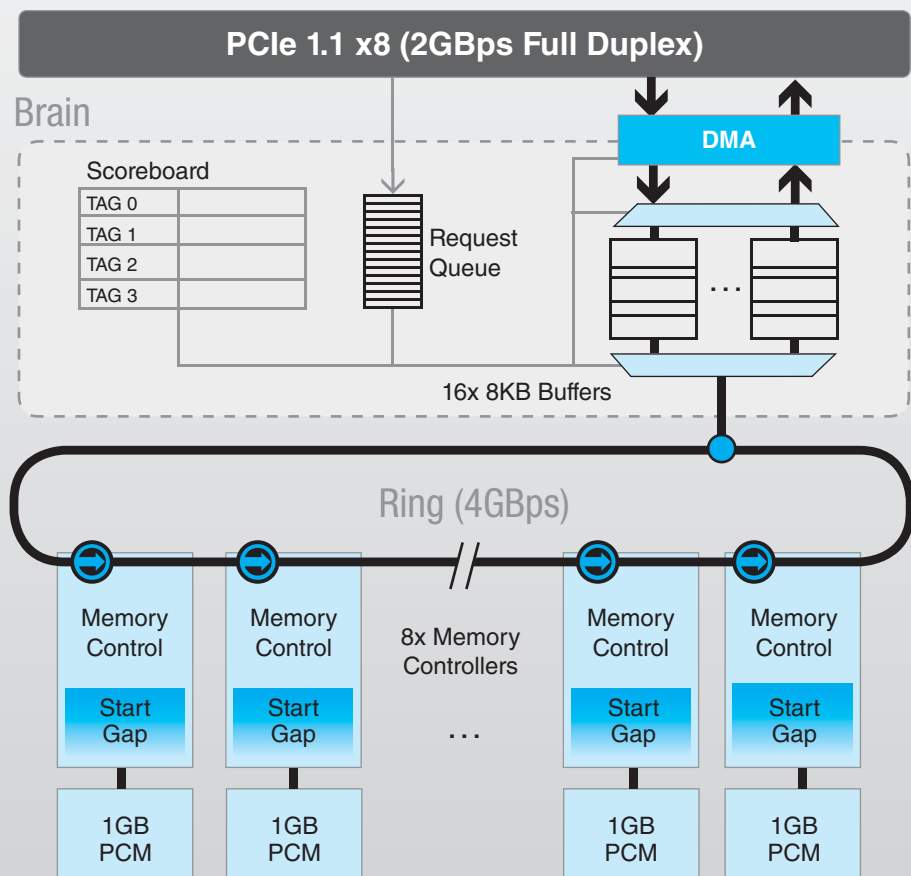
Source: UC San Diego

Phase-Change Memory Basics

The basic material behind phase-change memory can exist in either an amorphous phase or a crystalline phase.

The crystalline phase has an order to the lattice and a low resistivity (A), while the amorphous phase has a disordered lattice and a high resistivity (B).

In phase-change memory, the two phases occur when the material is heated by localized Joule heating. As shown in the illustration C, the layer of chalcogenide (the phase-change material) is sand-wiched between a pair of electrodes. A heating element connects the bottom electrode with the chalcogenide.

When electrical current is introduced into the area where the chalcogenide and heating element meet, the phase-change occurs in the bit.

"Each bit of memory in PCM in storage devices

like Onyx works by changing the state of a small amount of chalcogenide from crystalline to amorphous states," Caulfield says. "State changes are affected by heating the material, and then cooling it either quickly or slowly to form the two different states."

When reading the data bit, a small amount of voltage is applied to the bit. Depending on the

> In phase-change memory, the two phases occur when the material is heated by localized Joule heating.

phase of the material, the resistance to the voltage will be either large or small, revealing the data stored in the bit.

The phase-change alloys that work best include one of

the chalcogenide elements (D). One of the most common alloys for phase-change memory includes Germanium (Ge), Antimony (Sb), and Tellurium (Te). In fact, chalcogenide elements also are used in other phase-change data storage devices, such as CD-RW optical discs.

"Except, when used in CDs, the chalcogenide is melted with a laser, rather than an electrical current as in PCM," Caulfield says. "The optical properties of the two states are exploited [in a CD], rather than the electrical properties [as in PCM]."

A Crystalline Phase
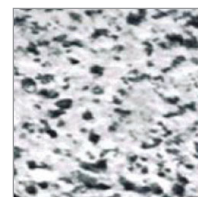
Illustration of Lattices   Magnified Photo

B Amorphous Phase

Illustration of Lattices   Magnified Photo

C

Top Electrode
← Chalcogenide
Resistor (Heater)
Bit
← Bottom Electrode
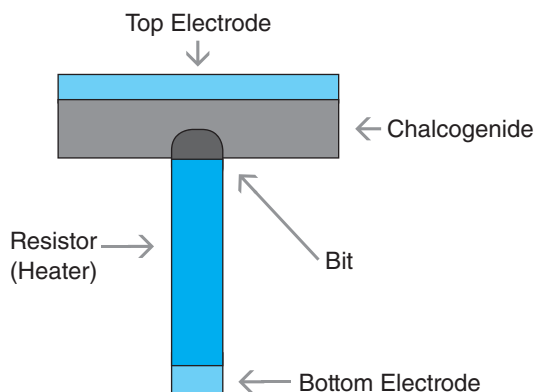
D Periodic Element Table

13 26.98154 3	14 28.0855 4,2	15 30.97376 ±3,5,4	16 26.98154 ±2,4,6
2740 933.5 **2.70** **Al** [Ne]3s²p¹ Aluminum	2740 933.5 **2.70** **Si** [Ne]3s²p² Silicon	2740 933.5 **2.70** **P** [Ne]3s²p³ Phosphorus	2740 933.5 **2.70** **S** [Ne]3s²p⁴ Sulfur
31 26.98154 3	32 26.98154 3	33 26.98154 3	34 26.98154 3
2478 302.92 **5.91** **Ga** [Ar]3d¹⁰4s²p¹ Gallium	3107 1211.5 **5.32** **Ge** [Ar]3d¹⁰4s²p² Germanium	876 (sub.) 1090 (28 atm) **5.78** **As** [Ar]3d¹⁰4s²p³ Arsenic	958 494 **4.79** **Se** [Ar]3d¹⁰4s²p⁴ Selenium
49 26.98154 3	50 26.98154 3	51 26.98154 3	52 121.757 -2,4,6
2350 429.78 **7.31** **In** [Kr]4d¹⁰5s²p¹ Indium	2876 505.12 **7.31** **Sn** [Kr]4d¹⁰5s²p² Tin	1860 903.91 **6.69** **Sb** [Kr]4d¹⁰5s²p³ Antimony	1261 722.72 **6.24** **Te** [Kr]4d¹⁰5s²p⁴ Tellurium

Sources: UC San Diego, Numonyx, Intel, and Ovonyx

- When writing large chunks of data, the flash drive was faster than the phase-change drive, although the researchers did not specify a performance percentage.

- When reading chunks of data of any size, the phase-change drive was faster than the flash drive by 11 to 430%.

- When reading or writing data, the phase-change drive required less CPU overhead to run its instruction set than the flash drive by 20 to 51%, because the PCM uses a less complex interface and driver than a flash drive.

Caulfield says the Onyx project shows that PCM could eventually provide better speed and better scaling than flash memory. Keep in mind that the Onyx project made use of a first-generation prototype PCM device, vs. a state-of-the-art flash drive.

"PCM's excellent small request performance makes it ideal for caching small updates or as a non-volatile cache to a large device," Caulfield says.

When compared to a magnetic hard drive, Onyx's performance is even more impressive. With a random 4KB read, Caulfield says, Onyx needs 38 microseconds to access the data, while a traditional hard drive needs 7,000 microseconds. With a 4KB write, Onyx requires 179 microseconds, vs. 7,000 microseconds for the hard drive, Caulfield says.

And he is sure that performance will improve down the road.

"As PCM continues to mature, we expect these latencies to decrease," Caulfield says. "Device densities will increase, resulting in small cell sizes. Also, better interfaces to the PCM will become available."

Building On Moneta

Onyx wasn't the first research project devoted to PCM devices at UC San Diego. Swanson led the Moneta project, too, on which work began in 2009. Work on the Onyx project followed, beginning in spring 2010.

"Onyx builds quite heavily on the results of the Moneta project, reusing much of the hardware infrastructure and the optimized software driver," Caulfield says. "Onyx includes a custom phase change memory controller, replacing the DDR2 memory controllers in Moneta, as well as our custom circuit board with the PCM chips on it."

The team plans to continue working with Onyx over the next few years, tweaking the research to take advantage of advancements in PCM technologies.

Going Forward With PCM

Looking ahead, Caulfield says the manufacturing of PCM chips won't require significantly different techniques than are already used for manufacturing flash memory.

"PCM SSD manufacturing should require roughly the same amount of work as flash-based SSDs," he says. "However, PCM has fewer device-level management complexities compared to flash, so the controller design should be simpler."

One of the potential drawbacks to phase-change memory is its life span. With Onyx, each PCM bit can handle about 1 million program cycles on average before an error occurs. Researchers will continue to work on bit management techniques to improve the life span of PCM. However, Caulfield says, the biggest drawback to PCM at this point is its density. With Onyx, the PCM devices offer a capacity of 16MB for each of the 40 chips contained on the PCM DIMM.

> With Onyx, each PCM bit can handle about 1 million program cycles on average before an error occurs.

"Compared with current flash memory densities of 2GB to 4GB per chip, PCM needs to scale quickly to become competitive," he says. "Current densities mean that the cost per bit in PCM is many times higher than flash."

As those improvements continue to be made to PCM, Caulfield says he expects it to compete with flash memory in the storage market.

"However, PCM could eventually find uses in other aspects of the computer system, for example, replacing DRAM DIMMs," he says.

Working Together

Another research project going on at the University of Virginia indicates that phase-change memory and flash memory could be used in combination in some SSDs to take advantage of the benefits of both technologies. Sudhanva Gurumurthi is an assistant professor in the Department of Computer Science at Virginia, and he has published and co-published some papers discussing a combination SSD where phase-change memory could be used when writing small chunks of data, while flash memory could be used when writing large chunks of data.

Caulfield says UC San Diego's research also has shown the potential that PCM has as a future storage technology in SSDs, either on its own or in combination with flash memory.

"Moneta and Onyx give a good example of what PCM controllers may look like," Caulfield says. "There are many opportunities for combining PCM with other storage technologies in a hybrid system." ▲

BY KYLE SCHURMAN
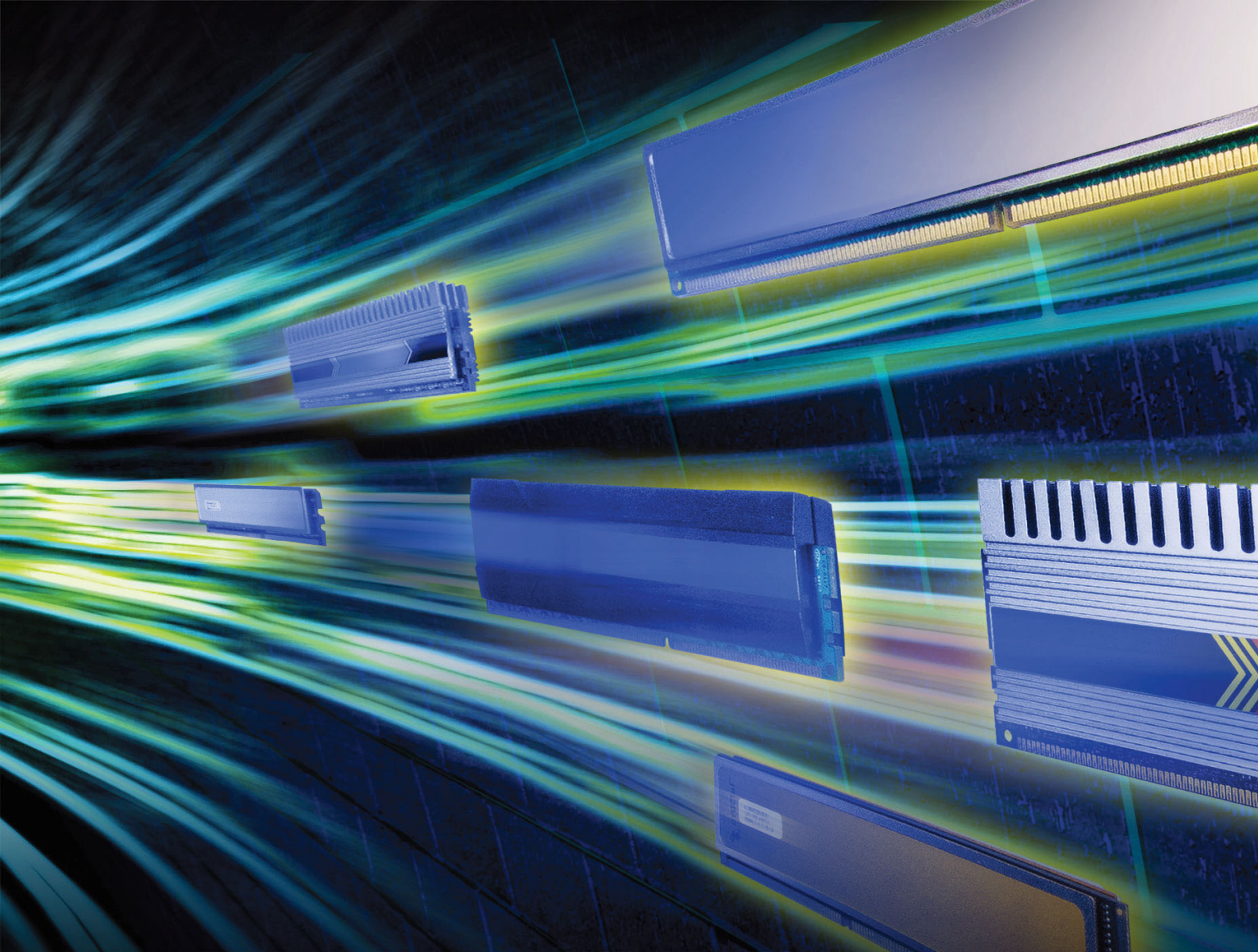
STICK SHIFT

"How much memory do you have in there?" The question (or one like it) is a familiar one for computer enthusiasts to ask and answer. If you find yourself also talking about things like your memory's speed, latency, and heat spreaders (and/or add-on cooling), you'll like this buyer's guide. Here, we'll talk about the nitty-gritty details on 36 of today's hottest RAM. But before we get started, we'll take some time to talk about the newest improvements and memory trends.

Sandy Bridge

We've talked a lot about the changes made in Sandy Bridge, and with memory, motherboards running Sandy Bridge are designed to run at 1.5V rather than the 1.65V maximum voltage found on previous generation P55 and H55 Intel chipsets. As such, you'll see phrases like "ready for Sandy Bridge" or "compatible with P67 and H67 chipsets" when shopping for new memory. If the memory voltage is pushed too high, the memory controller built into Sandy Bridge processors could overheat, which could damage or kill your processor. Many people have found that 1.65V memory modules currently function fine on Sandy Bridge, but because Sandy Bridge is relatively new, it's tough to determine if long-term damage is happening to the memory controller or processor.

The decrease in voltage means that you may need to invest in new memory if you're interested in overclocking. For example, an older kit that runs at 1.65V at stock speeds may require higher voltage when you're overclocking. And if you've moved to Sandy Bridge, that may not be worth the risk. Many "Sandy Bridge-ready" models feature a JEDEC (Joint Electron Device Engineering Council) SPD (serial presence detect) compatible voltage of 1.5V for a range of speeds, and generally you'll also see a maximum speed that has been tested to operate successfully at 1.65V.

Low Voltage

The JEDEC has also announced new specifications for DDR3L server memory, which are modules that run at 1.35V. With the new low-voltage memory, you'll also see a new module classification that includes an "L" after "PC3." For example,
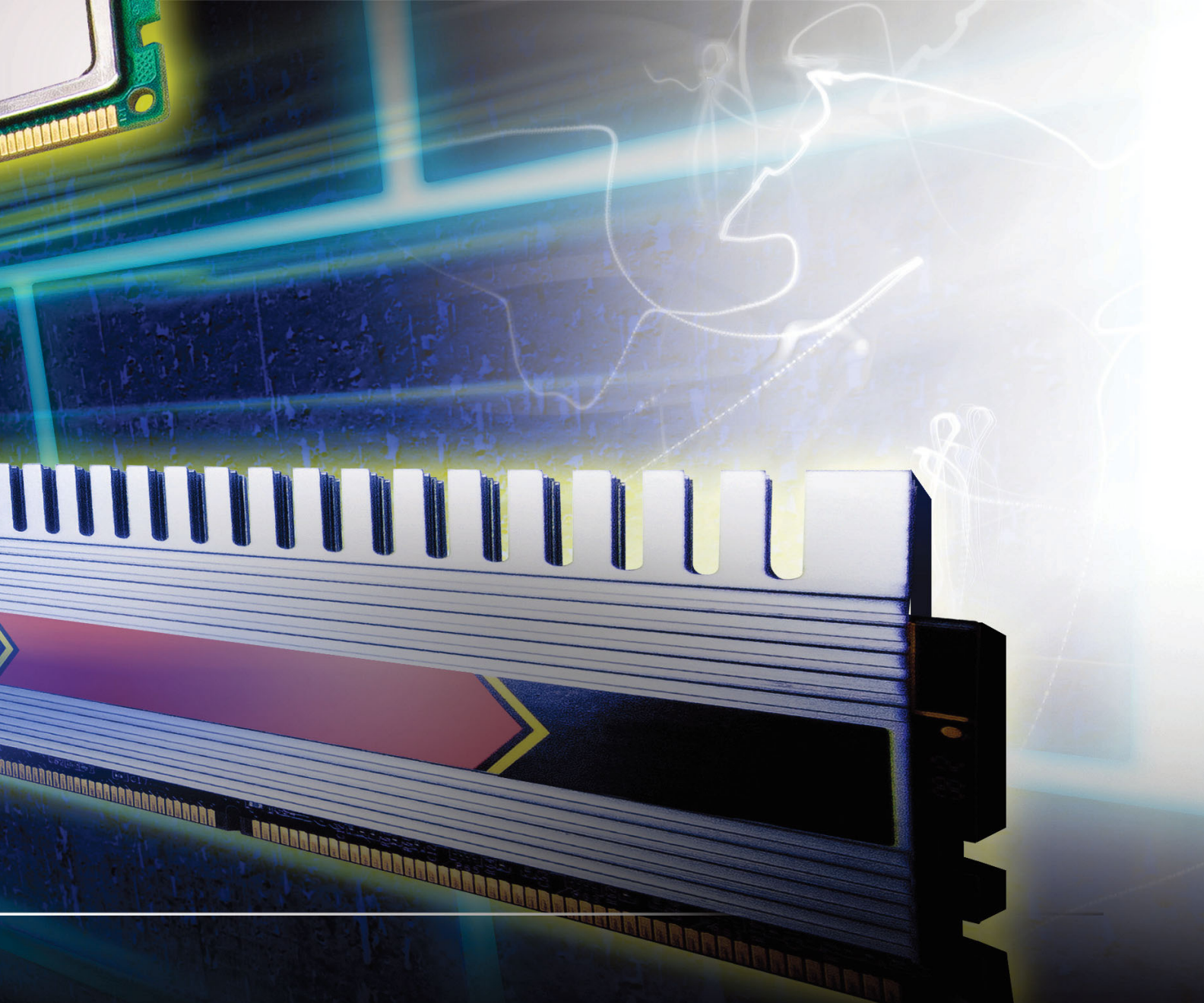
a kit of low-voltage DDR3-1333 would be listed as "PC3L-10600."

The JEDEC is also working on specifications for ultra-low-voltage DDR3, which will operate at 1.25V, that's expected to be titled "DDR3U." The ultra-low-voltage memory is designed for large server systems that use large amounts of energy, and it's estimated that 1.25V modules will use 10% less power than 1.35V DDR3L.

Llano Memory

AMD indicates that Llano works with DDR3 memory up to 1,866MHz with DIMMs and 1,600MHz with SO-DIMMS. AMD allows for a memory voltage of 1.5V with DDR3 speeds that are faster than 1,333MHz. With DDR3-1333MHz

memory, AMD recommends a voltage of 1.35V. AMD's Brazos platform can run DDR3-800MHz and 1,066MHz memory that operates at 1.35V or 1.5V. Brazos offers two DIMM slots, but the memory controller is single-channel. Llano includes a built-in dual-channel memory controller.

DRAM Prices

Memory prices dropped for much of last year, but the tsunami that struck Japan had slowed production and caused prices to rise in the beginning of 2011. The reason was that the memory manufacturers were unable to receive key materials, such as silicon wafers, from suppliers affected by the tsunami. A recent report from DRAMeXchange found that prices are no longer rising. The

average price of 2GB of DDR3 in May was $18.75, which was the same as it was the month before. DRAMeXchange also noted that manufacturers are getting back to full capacity production, because there's no longer a concern about the shortage of raw materials.

Memory vendors also put their own twists on RAM, as well, and in our entries, we'll detail the special features and cooling built into the modules. For convenience, we've split the RAM into a variety of DDR3 categories, including desktop, notebook, and Mac. We can never seem to include all the modules we like, but you'll find good selection among the 36 kits found here. ∎
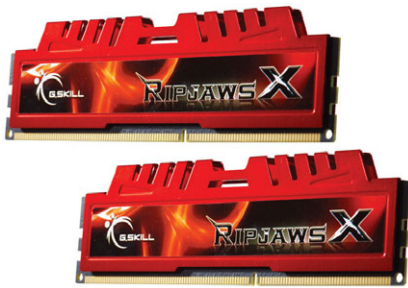
G.Skill F3-17600CL9Q-16GBXLD
$629.99
www.gskill.com

Why we dig it: This 16GB Ripjaws X series includes four 4GB modules and comes with a memory cooler with two fans. The Ripjaws X memory features speedy 2,200MHz modules, as well as quick CL9 latency for top-end performance. The modules operate at 1.65V and are Intel XMP-ready. G.Skill has tested the 16GB Ripjaws X series kit with several Intel Z68 and P67 chipsets.

Who should apply: Builders with tasks that require a large amount of fast, low-latency memory.

Capacity: 16GB (four 4GB modules)
Speed: PC3-17600 (2,200MHz)
Timings: 9-11-9-28

Kingston KHX2133C9AD3T1K4/8GX
$293.00
www.kingston.com

Why we dig it: HyperX T1 features a high-efficiency heatsink that delivers a longer memory life cycle under high-voltage operations. This kit consists of four 2GB modules that can run at speeds up to 2,133MHz at 1.65V.

Who should apply: Geared for extreme enthusiasts and professionals, the XMP-ready modules have two pre-programmed profiles: DDR3-2133 at 9-11-9-27 and 1.65V or DDR3-1866 at 9-9-9-27 and 1.65V.

Capacity: 8GB (four 2GB modules)
Speed: PC3-17000 (2,133MHz)
Timings: 9-11-9-28

Corsair CMZ16GX3M4A1600C9B
$199.99
www.corsair.com

Why we dig it: You won't run out of memory with Corsair's 16GB (four 4GB modules) 1,600MHz, CAS 9, 1.5V Vengeance kit. The modules' speed and Corsair's Vengeance design provide users with outstanding memory performance and stability. The sticks are also available in cerulean blue to perfectly pair with Intel's Sandy Bridge motherboards.

Who should apply: People who are using 2nd Generation Intel Core platforms. Enthusiasts who want ample memory capacity and good overclocking capability with SPD pre-programmed into the memory modules for ease of setup.

Capacity: 16GB (four 4GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 9-9-9-24

bou·tique *adjective:*
a small company that offers highly specialized services or products.

EGO *Maximal*

Geekbox recommends Intel® Core™ i7 Processors. Unlock your potential.

Corsair
TR3X6G1600C8D
$164.99
www.corsair.com

Why we dig it: This is Corsair's enthusiast DDR3 memory for Intel triple-channel Core i7 processors. Corsair indicates that its Dominator line was designed to have the highest performing IC, maximum overclocking capability, and efficient DHX cooling. And you'll also enjoy stability and reliability.

Who should apply: Enthusiasts who are using Intel Core i7 triple-channel platform and want a high-performance triple-module kit with aggressive timings, low latency, and pre-programmed SPD timings.

Capacity: 6GB (three 2GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 8-8-8-24

Crucial
BL2KIT51264FN2001
$139.99
www.crucial.com

Why we dig it: This set of Ballistix memory features finned heat spreaders with a thermal sensor. Crucial also provides a downloadable utility, so you can monitor temperatures in real time. Crucial indicates that the finned heat spreader design results in up to 30% better heat dissipation over its predecessors. The 2,000MHz memory supports the latest Intel Core i5 and Core i7 processors, and XMP profiles make setup a breeze.

Who should apply: Power users who want memory with cooling to overclock the modules for higher performance.

Capacity: 8GB (two 4GB modules)
Speed: PC3-16000 (2,000MHz)
Timings: 9-11-9-27
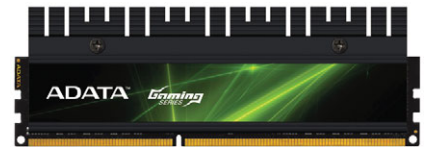
Adata
AX3U2000GC4G9B-DG2
$129.99
www.adatausa.com

Why we dig it: With the XPG Gaming v2.0 Series, Adata includes heat spreaders with its TCT1 (Thermal Conductive Technology) that makes contact with the PCB for improved heat dispersion. Adata also doubles the amount of copper in the PCB to increase energy efficiency. The 8GB kit runs at 2,000MHz using an 8-layer PCB for reliability.

Who should apply: Power users who want high-speed memory that's built using high-end thermal technology to avoid potential heat problems.

Capacity: 8GB (two 4GB modules)
Speed: PC3-16000 (2,000MHz)
Timings: 9-11-9-27

PNY
MD6144KD3-1600-X9
$129.99
www.pny.com

Why we dig it: This is a triple-channel kit from PNY that features its XLR8 heat spreaders, which are designed for reliability in demanding system tasks. PNY indicates the three sticks of RAM have been tested at speeds up to 1,600MHz with a latency of CAS9.

Who should apply: Those running the X58 platform wanting a reliable kit of triple-channel memory.

Capacity: 6GB (three 2GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 9-9-9-24

Corsair
CMZ8GX3M2A1866C9R
$144.99
www.corsair.com

Why we dig it: This 8GB (two 4GB modules) 1,866MHz CAS 9 Vengeance kit lets you push system performance. The 1.5V memory is designed for motherboards using Intel 2nd Generation Core platforms. The kit is now available with racing red heat spreaders and black PCB.

Who should apply: Power users interested in high-performance DRAM modules with overclocking capabilities.

Capacity: 8GB (two 4GB modules)
Speed: PC3-15000 (1,866MHz)
Timings: 9-10-9-24
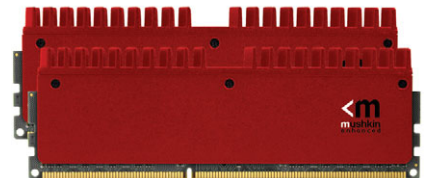
Mushkin
Ridgeback Redline 997008
$99.99
www.mushkin.com

Why we dig it: Mushkin's Ridgeback, which is a style of heat spreader designed to deliver optimal memory module cooling, is now available in red to coincide with Mushkin's Redline series. This 8GB kit is ready to perform on Intel's Sandy Bridge platform with its 1.5V voltage and 1,866MHz speed.

Who should apply: Power users who want speedy low-voltage memory to go with a new Intel or AMD processor.

Capacity: 8GB (two 4GB modules)
Speed: PC3-14900 (1,866MHz)
Timings: 9-10-9-27

Crucial
BL2KIT51264BA160A
$99.99
www.crucial.com

Why we dig it: The Ballistix Sport Memory features heat spreaders for good thermal performance, along with standard timings and voltages to provide you with a quality, reliable kit. Unlike traditional Ballistix products, the Sport series requires no special BIOS configuration. With the kit's affordable price, you can devote more of your budget to other high-end components. The modules operate at 1.5V to support the latest AMD and Intel processors.

Who should apply: The Ballistix Sport Memory is designed for entry-level and mainstream users to add memory capacity to their existing PC.

Capacity: 8GB (two 4GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 10-10-10-28
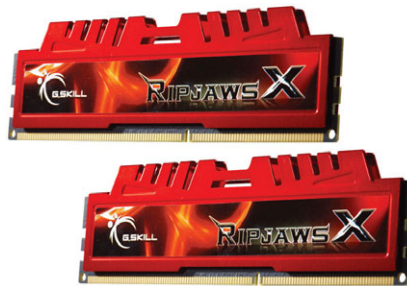
G.Skill
F3-17000CL11D-8GBXL
$99.99
www.gskill.com

Why we dig it: The Ripjaws X kit from G.Skill offers a 1.5V voltage that's designed to work on Intel's Sandy Bridge chipsets. We also like the slick red Ripjaws X heat spreaders, which will stand out in a case. The raised fins on the aluminum heat spreaders help G.Skill to run at 2,133MHz at CL11 timings. G.Skill indicates that the kit is Intel XMP-ready.

Who should apply: Power users who want fast memory that supports the low voltage required of today's memory controllers.

Capacity: 8GB (two 4GB modules)
Speed: PC3-17000 (2,133MHz)
Timings: 11-11-11-30

Transcend
TX2400KLU-4GK
$88.60
www.transcendusa.com

Why we dig it: The fastest of Transcend's aXe line of memory, this 4GB kit operates at 2,400MHz. The XMP profile for the 2,400MHz speed includes timings of 10-12-11-28 and a voltage of 1.65V. Transcend also builds in a JEDEC standard of 1,333MHz at timings of 9-9-9-24 and 1.5V. Transcend's aXe heat spreader is silver and features tall fins for dissipating the heat generated by the fast memory speeds.

Who should apply: Power users who are first and foremost concerned about a module's speed.

Capacity: 4GB (two 2GB modules)
Speed: PC3-19200 (2,400MHz)
Timings: 10-12-11-28
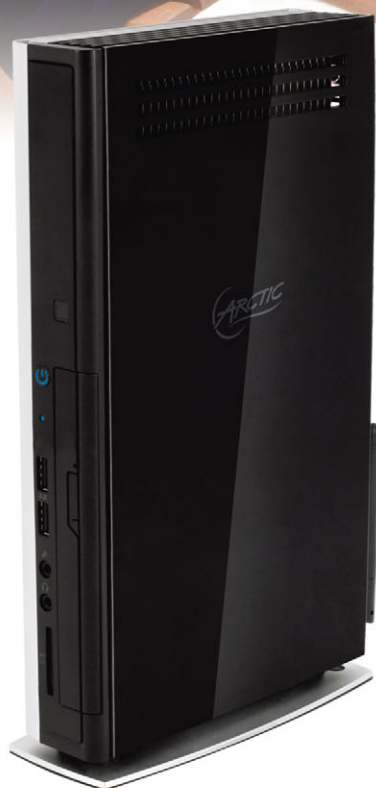
Corsair
CML8GX3M2A1333C9
$84.99
www.corsair.com

Why we dig it: This Corsair Low Profile Vengeance memory kit comes with 8GB of memory and runs at a voltage specification of 1.35V to support low power requirements of specific Intel and AMD dual-channel motherboards. Each module is built using carefully selected DRAM to allow excellent overclocking performance. This kit is available in an arctic white-colored heat spreader and black PCB for a cool aesthetic. Corsair covers the kit with a limited lifetime warranty.

Who should apply: People who are looking for a low-voltage DRAM kit to pair with a dual-channel motherboard.

Capacity: 8GB (two 4GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 9-9-9-24

G.Skill
F3-12800CL9D-8GBSR2
$84.99
www.gskill.com

Why we dig it: The Sniper series offers a distinctive sniper rifle heat spreader and runs at 1.25V. The ultra-low-voltage memory is compatible with Intel's Core i7, i5, and i3 processors and is ideal for high-performance systems where the case's internal heat may be a concern. G.Skill builds in Intel XMP timings.

Who should apply: Builders who want low-voltage memory that still provides the speed they need to game, render, and perform other memory-intensive tasks.

Capacity: 8GB (two 4GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 9-9-9-24

Crucial
BL2KIT25664ST1608OB
$83.99
www.crucial.com

Why we dig it: This set of Ballistix Smart Tracer Memory features programmable orange and blue activity LEDs on the top, as well as ground-effect LEDs along the bottom. The 4GB Smart Tracer kit allows you to choose from four different LED patterns, adjust the brightness, and turn the LEDs on/off. The 1,600MHz modules are also compatible with Crucial's real-time temperature monitoring software.

Who should apply: Performance enthusiasts and case modders who want to push the speed of their computer while also adding flash to their boxes.

Capacity: 4GB (two 2GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 8-8-8-24

Transcend
JM1600KLN-8GK

$77.70
www.transcendusa.com

Why we dig it: The JetRam dual-channel kit runs at up to 1,600MHz and features 8GB of memory. The two 4GB modules feature CL11 timings.

Who should apply: Budget builders looking for an affordable set of high-density, 1,600MHz RAM for their desktop.

Capacity: 8GB (two 4GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: CL11

Wintec
3OH16009U9H-6GT

$72.99
www.wintecind.com

Why we dig it: It's one of the most affordable 1,600MHz triple-channel kits available, and it features an SPD voltage of 1.5V. The Wintec One line of memory includes a heat spreader with a series of Air-Flow Channeling Fins to help effectively cool the memory.

Who should apply: X58 builders with cases where the heat inside the case would require memory that's been optimized for cooling efficiency.

Capacity: 6GB (three 2GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 9-9-9-24

Adata
AX3U1600GC4G9-2G

$69.99
www.adatausa.com

Why we dig it: Adata builds the XPG Gaming Series with high-quality six-layer PCB. The two 4GB modules run at 1,600MHz with a voltage between 1.55 and 1.75V tested at latency settings of 9-9-9-24. SPD-programmed JEDEC standards are also included for 1,333MHz and 1,066MHz, also at a latency of 9-9-9-24.

Who should apply: XPG stands for Xtreme Performance Gear, so the memory is designed for performance enthusiasts.

Capacity: 8GB (two 4GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 9-9-9-24

Adata
AD3U1333C4G9-DRH
$67.99
www.adatausa.com

Why we dig it: This Premier Series memory from Adata operates at 1,333MHz, and the kit includes two 4GB modules. We also like that the dual-channel memory operates at 1.5V to support the power standards of today's Intel and AMD processors.

Who should apply: Budget buyers looking for an affordable DDR3 kit to complete their build.

Capacity: 8GB (two 4GB modules)
Speed: PC3-10666 (1,333MHz)
Timings: 9-9-9-24

Kingston
KHX1600C9D3K2/4GX
$40
www.kingston.com

Why we dig it: This is the ideal frequency for enthusiasts, gamers, and system integrators who want higher performance without making manual changes—and at a low cost. HyperX Genesis memory features a heat spreader with a reflective stripe that forms an "X" on each module. The kit has been tested to run at DDR3-1600 speeds at low latency timings of 9-9-9-27. It operates at 1.65V.

Who should apply: Power users who are looking for fast memory at prices that won't stretch their bank account.

Capacity: 4GB (two 2GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 9-9-9-27
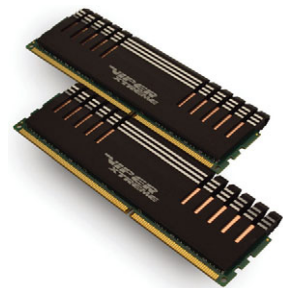
Patriot Memory
PXD38G1600LLK
$44.99
www.patriotmemory.com

Why we dig it: The 4GB Viper II Xtreme Division 2 memory features a heat shield with a copper core that helps to spread heat through the exterior aluminum shield. The kits are hand-tested and validated to ensure stability and performance on Intel 6 Series chipsets. We also like that Patriot Memory includes XMP-ready timings for quick, stable overclocking. Patriot backs the kit with a lifetime warranty.

Who should apply: Enthusiasts who want to fill their system with fast memory that offers Intel XMP settings for convenient overclocking to high, stable settings.

Capacity: 4GB (two 2GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 8-9-8-24

Love at first sight

LeveL 10 GT
Driving Inspiration

Snow Edition

Don't let the good look fool you. Level 10 GT – Snow Edition is a streamlined computer case engineered to accelerate cooling and offers full suite of technical features that redefines the definition of performance PC. Three oversized 200mm ColorShift fans and one 140mm TurboFan ensure your high-end graphic cards, CPU and hard drives are all quietly cooled. The keyword is "quietly". All intake fans come with built-in filter that can be easily cleaned without the use of any type of tools. Plug&Play side panel fan, 240mm high-efficiency water cooling radiator support and much more, to find out, visit us at www.thermaltakeusa.com. Are you in love yet?

Thermaltake
Cool all Your Life

Tt eSPORTS
By Thermaltake

facebook.com/ThermaltakeInc
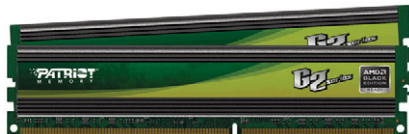
Patriot Memory PG234G1600ELKA
$43.99
www.patriotmemory.com

Why we dig it: This is an AMD Edition of Patriot Memory's G2 Series, and it's tested on AM3 7, 8, and 9 series platforms. The 4GB kit runs at 1,600MHz with a voltage between 1.65V and 1.7V. Patriot uses a low-profile heat spreader to efficiently cool the memory and avoid interfering with a large CPU cooler.

Who should apply: People with an AMD processor who want memory that will perform at the highest settings without messing around in the BIOS.

Capacity: 4GB (two 2GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 9-9-9-24

PNY MD4096KD3-1333
$39.99
www.pny.com

Why we dig it: An affordable 4GB kit of DDR3 memory that also features golden orange heat spreaders that will stand out inside your case. PNY supports the memory with a lifetime warranty.

Who should apply: System builders on a budget who are using a case with a clear side panel and want an attractive set of memory modules.

Capacity: 4GB (two 2GB modules)
Speed: PC3-10666 (1,333MHz)
Timings: CL9

Wintec 3AXH1333C9WS4GK
$39.99
www.wintecind.com

Why we dig it: The 4GB Wintec AMPX kit operates at 1,333MHz. The 1.5V modules feature black heat spreaders and operate at CL9 timings. Wintec offers a lifetime warranty on the modules.

Who should apply: Builders who want to use an affordable set of memory in their new dual-channel system.

Capacity: 4GB (two 2GB modules)
Speed: PC3-10666 (1,333MHz)
Timings: 9-9-9-24
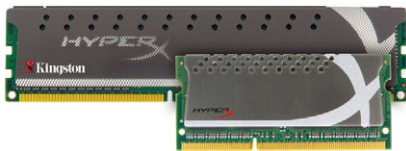
Kingston
KHX1600C9S3P1K2/8G
$109
www.kingston.com

Why we dig it: When plugged into notebooks that use Intel's 2nd Generation Core processors, HyperX Plug and Play 8GB 1,600MHz will automatically "play" at 1,600MHz at 1.5V. No manual BIOS settings are required, as the modules are pre-programmed using JEDEC-compliant settings. In addition, the modules should be compatible with notebooks using DDR3 SO-DIMMs.

Who should apply: Enthusiasts looking for faster frequencies who don't want to bother with manually changing BIOS settings.

Capacity: 8GB (two 4GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 9-9-9-27

G.Skill
F3-12800CL9D-8GBSQ
$89.99
www.gskill.com

Why we dig it: This affordable 8GB kit runs at up to 1,600MHz with latency timings of 9-9-9-28. We also like that it runs at the low voltage of 1.5V, which should help to reduce the heat generated by the memory inside your laptop and save on battery life. The 8GB capacity is also good for those who push their system with video- and photo-editing applications that can take up much of your PC's memory.

Who should apply: Enthusiasts who want to game and perform other demanding tasks on their notebooks.

Capacity: 8GB (two 4GB modules)
Speed: PC3-12800 (1,600MHz)
Timings: 9-9-9-28
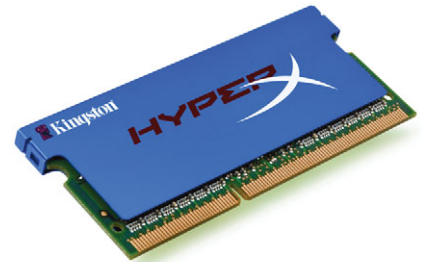
Kingston
KHX1333C7S3K2/4G
$84
www.kingston.com

Why we dig it: Kingston builds its HyperX SO-DIMM heat spreader onto the modules to help improve heat dissipation. The modules operate at 1,333MHz at 1.5V and feature timings of 7-7-7-20. The SO-DIMMs are backed by Kingston's lifetime warranty.

Who should apply: This low-latency HyperX SO-DIMM notebook memory is affordable and meets the demands of those looking to add quality memory to their notebook.

Capacity: 4GB (two 2GB modules)
Speed: PC3-10600 (1,333MHz)
Timings: 7-7-7-20
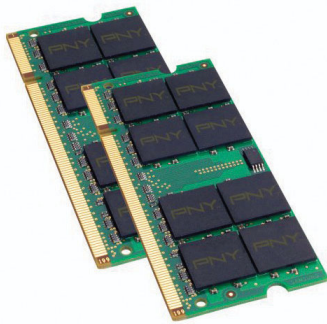
PNY
MN8192KD3-1333
$79.99
www.pny.com

Why we dig it: This PNY Optima Memory is compatible with both Windows and Mac notebooks, and it can operate at 1,333MHz or 1,066MHz. PNY also offers a free Sony movie download with the kit, letting you select from up to 35 movie titles for unlimited viewing on up to two computers.

Who should apply: Notebook owners who want to upgrade their laptop's memory and receive a free movie while doing so.

Capacity: 8GB (two 4GB modules)
Speed: PC3-10666 (1,333MHz)
Timings: CL9

Corsair
CMSO8GX3M2A1333C9
$84.99
www.corsair.com

Why we dig it: This is an 8GB SO-DIMM kit that includes two 4GB modules that run at 1,333MHz. There's no built-in heat spreader, but the modules are still capable of running at a relatively low latency of 9-9-9-24 at 1.5V. Corsair indicates that the modules are designed for use in all systems with SO-DIMM slots.

Who should apply: The 8GB capacity is perfect for power users who want to increase the size and speed of the memory in their notebook.

Capacity: 8GB (two 4GB modules)
Speed: PC3-10600 (1,333MHz)
Timings: 9-9-9-24
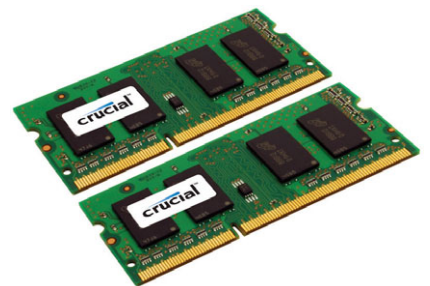
Crucial
CT2KIT51264BC1339
$77.99
www.crucial.com

Why we dig it: This affordably priced 8GB kit lets you upgrade the memory on your notebook to fast DDR3-1333 speeds, and Crucial uses 9-9-9-24 timings for relatively low latency. We also like Crucial's Memory Advisor Tool, which helps you make sure you're selecting the right memory for your notebook.

Who should apply: Users who want an easy way to find the right kit for their notebook.

Capacity: 8GB (two 4GB modules)
Speed: PC3-10600 (1,333MHz)
Timings: 9-9-9-24
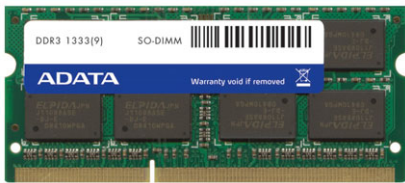
Adata
AD3S1333C4G9-2

$59.99
www.adatausa.com

Why we dig it: This 4GB Supreme Series SO-DIMM kit consists of two 2GB modules that operate at 1,333MHz. Adata indicates that it stringently tests its Supreme Series modules for cross-platform support and durability, and it uses only originally branded DRAM ICs that are built on full data sheets, which help to improve reliability and performance.

Who should apply: Power users who are interested in memory that's been tested to work in a variety of SO-DIMM environments.

Capacity: 4GB (two 2GB modules)
Speed: PC3-10666 (1,333MHz)
Timings: 9-9-9-24

Mushkin
996647

$50
www.mushkin.com

Why we dig it: This 8GB Mushkin Essentials kit is a superb upgrade for those running 64-bit operating systems, which can take advantage of the RAM's 8GB capacity. Mushkin offers a lifetime warranty for its Essentials memory, and the modules operate at 1.5V.

Who should apply: Notebook owners wanting to increase their systems' ability to work with photo-editing and video-editing applications, as well as improve overall system speed.

Capacity: 8GB (two 4GB modules)
Speed: PC3-10666 (1,333MHz)
Timings: 9-9-9-24

Wintec
3VH13339S9-4GR

$33.99
www.wintecind.com

Why we dig it: This single 4GB module is perfect for notebooks with one free SO-DIMM slot for another stick of DDR3-1333. The Wintec Value memory features a latency of CL9 and operates at 1.5V.

Who should apply: People looking to upgrade the memory capacity of their notebooks.

Capacity: 4GB (one 4GB module)
Speed: PC3-10666 (1,333MHz)
Timings: 9-9-9-24

Kingston
KTA-MB1066K2/8G
$85
www.kingston.com

Why we dig it: This memory is compatible with Intel Core 2 Duo iMacs (20-inch, 21.5-inch, 24-inch, and 27-inch models), as well as recent MacBook Pro notebooks (13-, 15-, and 17-inch models). The 8GB capacity lets iMac and MacBook users max out their system memory.

Who should apply: Apple users who want to fill their system with memory that has been tested for the Mac OS platform.

Capacity: 8GB (two 4GB modules)
Speed: PC3-8500 (1,066MHz)
Timings: 7-7-7-20
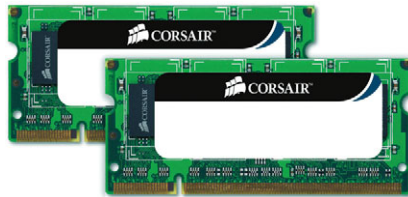
Corsair
CMSA8GX3M2A1066C7
$84.99
www.corsair.com

Why we dig it: This 8GB SO-DIMM kit will have your MacBook or MacBook Pro racing along. It's ideal for anyone working with images, video, and content creation tools. The DDR3-1066 memory features a CAS latency of 7 and runs at 1.5V.

Who should apply: People with a MacBook or MacBook Pro. Just replace your current modules and enjoy the extra memory capacity.

Capacity: 8GB (two 4GB modules)
Speed: PC3-8500 (1,066MHz)
Timings: 7-7-7-20
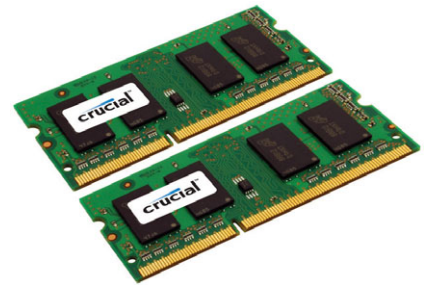
Crucial
CT1895141
$77.99
www.crucial.com

Why we dig it: This module is guaranteed to be compatible with the 15-inch MacBook Pro running Intel's 2.2GHz Core i7 processor. And the 8GB capacity means that you'll be able to max out its memory. The kit operates at 1.5V with timings of 9-9-9.

Who should apply: 15-inch MacBook Pro owners who want an affordable way to reach their system's memory capacity.

Capacity: 8GB (two 4GB modules)
Speed: PC3-10666 (1,333MHz)
Timings: 9-9-9

Inside The World Of Betas

MetroTwit v0.8.1.0

TweetDeck's all-function-and-no-beauty design can leave even a power user cold. Enter MetroTwit, which combines the new Microsoft "Metro" design philosophy and many of TweetDeck's best features into a singularly attractive-looking client with lots of useful features.

MetroTwit looks great if you like the look of Windows Phone 7 and Windows 8 demo—smooth scrolling, fonts, transitions, and so forth. Even the two themes, Dark and Light, are smartphone-like.

By default, MetroTwit lists tweets in four columns: your friends' tweets, tweets that mention you, direct messages, and public messages. Search results appear in another column, and all of the columns are "infinitely scrollable"; just keep scrolling down to see more and more

tweets or search results. Other handy features include a tweet entry field (so you can keep the world updated without leaving MetroTwit), drag-and-drop image uploading (it works with yfrog or TwitPic), and automatic segmentation of longer tweets through TwitLonger. (Yeah, it's OK to chuckle at these product names.) There are also buttons for searching for users by profile and for searching Twitter for trends. The results for these also appear within their own column.

There are quite a few glitches dealing with updates and screen redraws. And, as we mentioned earlier, you need a lot of horsepower for MetroTwit to work smoothly. However, even given these problems, we're
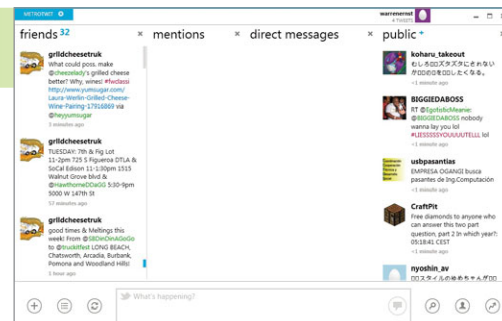
MetroTwit v0.8.1.0
Publisher and URL: Pixel Tucker, www.metrotwit.com
ETA: Q4 2011
Why You Should Care: Perhaps the most attractive Twitter client for Windows available.

taken with MetroTwit's fetching appearance enough to keep using it. ∎

BY **WARREN ERNST**

Greenshot 0.8.1.224

In the past, the only people who really needed software for taking screen shots were software documentation staffers and software reviewers. But with so much of our lives happening online and on-screen, dedicated screen shot software is starting to make sense for even casual users. Still, there's no reason for that software to cost anything for only occasional use, so Greenshot looks like a good option.

Greenshot is a small download that, once installed, lives in your Taskbar Tray, waiting for you to press PRINT SCREEN (along with any CTRL, ALT, or SHIFT modifiers) for it to leap into action. Greenshot immediately captures the entire screen, the active window, or a selectable region, and then opens the image into its own editor, which is really where the magic happens.

The editor is simple and fun to use. Tools along the left side let you add cursors,

text, highlight bars, circles/lines/squares, magnification regions, and "obfuscation" effects (blurring or pixelation), with lots of options running along the top edge of the window. All these are editable and movable after placement, which is great, but you can't edit or move them once you've saved your screen shot, which is bad. In other words, if you circle something on the screen shot, save the file and close Greenshot, and then realize you should have circled something else, you need to retake the screen shot and start over.

The best tools of the genre have a way to save the marked-up screen shot in a format for editing the callouts later, or, in some cases, automatically maintain a history or library of previously captured and edited screens. None
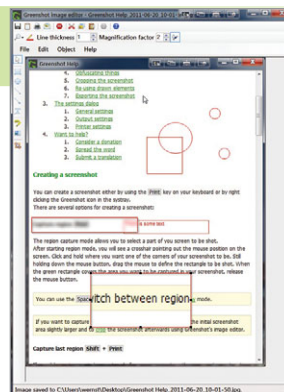
Greenshot 0.8.1.224
Publisher and URL:
The Greenshot Team, getgreenshot.org
ETA: Q4 2011
Why You Should Care:
A good, fast, free screen shot utility comes in handy sometimes.

of these are available to our knowledge in free (or ridiculously cheap) screen shot programs. Perhaps that's the natural split between paid products and the rest.

This most recent beta was the result of a major bug hunt, and the effort shows: Greenshot is stable, quick, and worth using right away. ∎

BY **WARREN ERNST**

The Latest Upgrades To Keep You Humming Along

Some longtime favorites of the power user crowd received updates this month, including a major release of µTorrent, a new PortableApps Platform, and an upgrade to System Mechanic.

Software Updates

Adobe AIR 2.7

The latest iteration of the AIR runtime tools that let Flash programs run outside of a browser now renders AIR apps on iOS up to four times faster in CPU mode. Content developers will no doubt be pleased that AIR 2.7 includes the same measurement tools as Flash Player 10.3, which lets them gather consumption data in real time.

www.adobe.com/products/air

Free Download Manager 3.8 RC Build 1051

A flurry of new beta builds for this file download manager and Flash video downloader add a number of features, including FileSonic and Firefox 5 support, "%userprofile%" macros, and a handful of small interface changes. The series of beta builds squashes bugs and corrects crash issues, too.

www.freedownloadmanager.org

GPU-Z 0.54

The video card diagnostics and information utility receives the following batch of enhancements (among others): faster starts (especially on AMD cards), better rendering on high DPI screens, detection of more Sandy Bridge GPUs, as well as a vast number of GeForce and Radeon models. The update also corrects OpenCL detection on some Nvidia drivers.

www.techpowerup.com/gpuz/

PortableApps.com Platform 2.0 Beta 5

Developers are readying a major version update for this popular platform that lets users load "portable" versions of Firefox, OpenOffice.org, VLC Media Player, and more onto removable drives. Beta 5 includes the PortableApps.com Updater, which tracks your installed apps and keeps them updated with the latest versions. Also new is a "theming engine" that lets you customize the look of your menus.

portableapps.com

SeaMonkey 2.2

The latest Windows version of this all-in-one bundle of Web-related clients and tools (browser, email, chat, HTML editor, etc.) now integrates extensions and add-ons into the SeaMonkey installer; they aren't optional anymore. Version 2.2 lets you change archiving options in the Copies & Account Settings section. Changes in the underlying Mozilla platform for the suite include support for CSS animations, as well as better support for HTML5, XHR, MathML, SMIL, and canvas.

www.seamonkey-project.org

System Mechanic 10.5

The venerable system tune-up and repair tool from iolo technologies adds several new features, including automated driver updating, accelerators that quicken program launches and optimize solid-state drives, a redundant program/file remover, and a new home licensing model that allows multiple PCs in a home to use the program.

www.iolo.com

Trillian For Windows 5.0 Build 34

Bugs are the primary target for this release of the multiplatform instant messaging platform. Build 34 squashes a Twitter-related error that breaks the unread message count. Trillian's devs also fixed some problems in Skype that caused Trillian to freeze.

www.trillian.im

µTorrent 3.0

The venerable torrent client is now available as an official, stable version of the 3.0 upgrade, which had been in beta for the last few months. Chief among the new features is progressive downloading that enables file previews before completion. BitTorrent has also introduced remote access capability, which lets you access your µTorrent client from any Web browser or from the µTorrent Android app.

www.utorrent.com

Winamp 5.61

One of the oldest MP3/digital music players receives a batch of fixes, including better compatibility with Internet Explorer 9, problems with album art viewing, and syncing problems with the iPod nano and shuffle 4G.

www.winamp.com

Wipe 2011.11

This tool that helps wipe browser history fixes an activation issue. Version 2011.11 is the latest in a series of recent updates, including the important version 2011.10, which added support for Firefox 5.

privacyroot.com/programs/info/english/wipe.html

Xmarks For Firefox 4.0.1

The latest release of the bookmark syncing tool for browsers adds a Repair feature to its Firefox variant. By using the Repair tool, Xmarks attempts to recover from bookmark syncing errors.

www.xmarks.com

Driver Bay

Creative Live! Cam Socialize HD AF Firmware 1.2.1.0

For Creative's Web cam, the firmware upgrade improves image quality when making those all-important Skype calls.

support.creative.com

BY STEVE SMITH

LazySave 4.0

Nighttime backups burn power with 24/7 operation, and daytime backups soak up valuable system resources needed by other applications during regular use. What to do?

LazySave's outstanding answer is to run backups as a screen saver task—a solution so obvious in hindsight that we have to wonder why Microsoft didn't plant it in Windows ages ago. You configure LazySave through the screen saver settings menu, where you establish source and target folders (including LAN locations) and indicate whether to include subfolders. Although LazySave's backup functions are awkwardly labeled, they essentially boil down to folder mirroring and differential sessions. Once you back up everything, differential sessions only copy data that has changed since the last session.

When the screen saver kicks on, your screen turns black, and a box showing the backup progress will slowly bounce around

LazySave 4.0
$23.99
www.lazysave.com

the screen. You can create as many backup profiles as you like, and LazySave also includes a logging function so you can check the success of past sessions.

We only encountered two issues with LazySave. As the publisher notes, LazySave won't work under 64-bit Windows 7. Second, there's no provision for bare metal backups, which we now consider to be essential in backup apps not only because bare metal restorations save untold hours of user time but also because Windows' backup tool can do it—free.

We noticed that LazySave keeps all screens in a multimonitor setup black but powered up. We suggested that unneeded screens should enter sleep mode, and the developer
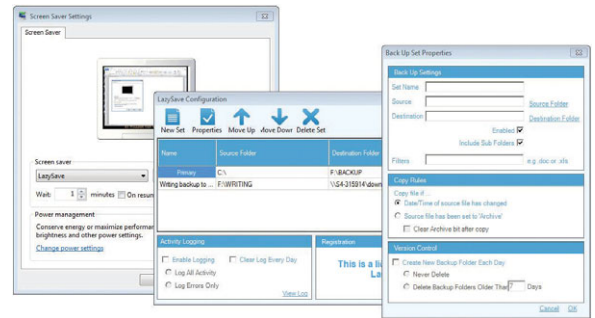
tells us that this is both possible and now on the list of requested enhancements.

Given the capabilities of free and similarly priced backup utilities, we suspect LazySave would fare much better at the $10 to $15 level, but it's important to note that LazySave isn't trying to be a full-blown backup offering. It only wants to keep your hour-by-hour file changes protected. Once you walk away, your new data is safe. This is a different approach than conventional backup scheduling. ∎

by William Van Winkle

Siber Systems RoboForm Everywhere v7.3.2

We all know that reusing passwords across many sites makes for terrible security, but who *doesn't* do this? With a password manager such as RoboForm, maybe you can do your online security properly.

RoboForm lets you create different login credentials for every site or service you visit, memorizes them in the form of "passcards," and manages all of them with a single master password. RoboForm encrypts everything with 256-bit AES.

By default, RoboForm supports IE, Firefox, Chrome, and Opera, plus dozens of other apps. OS support spans Windows, Mac, and Linux, and there are RoboForm apps for most major phone platforms. If you fill out a profile sheet, RoboForm will also provide one-click fill-in of standard Web-based forms.

Most importantly, the cloud-based Robo-Form Online service (included with the RoboForm Everywhere license) syncs your

RoboForm Everywhere v.7.3.2
$9.95 (first year, $19.95/year thereafter)
Siber Systems | www.roboform.com

logins and bookmarks across multiple systems. If a meteor hits your house and vaporizes all of your computers, you can still recover all of your logins (assuming you survived).

RoboForm isn't quite perfect. We found that on sites that handle password input via a pop-up window or require multiscreen authentication, you might need to create two passcards, thus requiring two clicks. This still beats typing in passwords any day. And if you encounter pages without a password requirement that still need ID filling, you need to disable RoboForm's default setting to only autofill pages with passwords.

RoboForm Everywhere also includes RoboForm2Go, which lets you securely run

your RoboForm assets from a USB drive on any system. RoboForm2Go doesn't yet work under Chrome or Opera; IE9 and Firefox 5 aren't currently supported, either. Overall, RoboForm is a great security enhancement, but paying $20 per year for the service may strike some as steep. ∎

by William Van Winkle

Mariner Software Paperless For Windows

Expected to emerge from beta by the time you read this, Paperless takes all of your important papers—receipts, business cards, warranty statements, etc.—and lets you scan them into PDFs. (Digital copies are legally viable in most cases, including with the IRS.) Paperless runs its OCR (optical character recognition), and then you tie metadata to each image. You can organize all of your items into sensible categories and libraries, and Paperless' Search function lets you harness all of this metadata and find exactly the items you want in seconds.

From the main UI, you can use the Scan button to import a single item or Multi Scan for multiple-page items into a multipage PDF. Unlike in most other document management apps, you don't enter data at the point of scanning. Rather, new scans drop into a general inbox. Once you finish filling in data for an inbox item, click Done to make it sortable into various

Paperless For Windows
$49.95 | Mariner Software
www.marinersoftware.com

collections. As in iTunes, you can make "Smart Collections" that automatically gather items with the same given criterion into a common folder.

Paperless comes with the usual data fields (type, title, category, payment type, etc.), and you add new entries for each field over time. Thanks to its OCR, though, Paperless will eventually learn your commonly used document sources and start to autofill certain fields for you. For example, after entering a couple of Applebee's receipts, Paperless might automatically know to fill in a category of Business Expenses and a subcategory of Meals. The program also has a very flexible, customizable reporting module able to send data into Quicken's QIF, CSV, and other styles for end-of-year review.
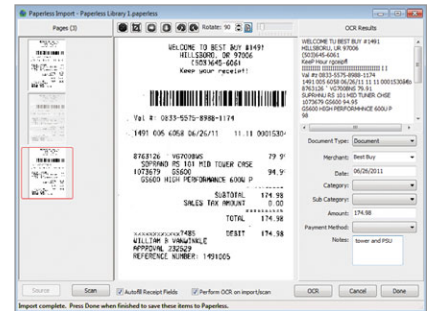
Our only snag with Paperless was that the driver for our Canon MP-990 would lock when we tried to scan through it, but standard WIA drivers worked just fine. Paperless for Windows is rather plain-looking and at times unintuitive. Those used to wizard-guided software may be stumped at points and need to read the manual, but it will be time well spent for such a useful, productivity-oriented tool. ■

BY WILLIAM VAN WINKLE

Systweak RegClean Pro 6.21

If we handed you two different jars of multivitamins and said, "See which one of these works better," you would immediately understand why it's so hard to review Registry cleaners. It's not like you use one and suddenly feel better. You may get some dead links cleaned up and clear a bit of memory, but, at best, Registry cleaners are preventive medicine.

But that's not why people buy them. We buy Registry cleaners to increase performance. We buy them to minimize system crashes and improve startup times. Unfortunately, we have no hard data indicating Registry cleaners actually do any of this. Systweak notes, "Cleaning invalid Registry errors increases application response times. This results in faster access to programs and applications." But no percentages, sources, benchmark results, or any other tangible references are given.

RegClean Pro 6.21
$29.95 | Systweak
www.systweak.com

Registry cleaners, if improperly designed, can also damage your Registry and cause problems. This is why a cleaner needs to include a Registry backup function, and RegClean Pro does. On one fairly heavily used office system, a backup took about 25 seconds. (You can see a log of backup records under the program's Backup Registry tab.) As with system restore points, if you run into trouble after making Registry changes, just highlight the backup session you want and click the Restore button. You will also find a Defrag Registry function. Again, this may be practical, but we sure couldn't tell a difference after running it.

Our initial Registry scan discovered 576 errors, and across the four categories
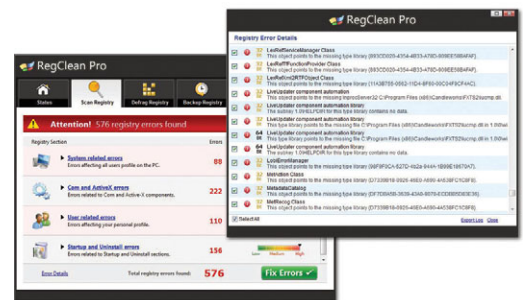
RegClean Pro tracks—System-related, Com And ActiveX, User-related, and Startup And Uninstall—all were rated as "High" in terms of "damage level." RegClean Pro cleaned all but 47 on the first pass, and one more cleaning eliminated the remainder. In comparison, CCleaner only found 207 issues. Does this mean that RegClean Pro is over twice as effective . . . or that it's merely finding many more inconsequential "errors"? We can't know. But we do know that CCleaner and other cleaners like it are free. ■

BY WILLIAM VAN WINKLE

Freebies From The Big Dogs

The strategy at major digital providers such as Microsoft, Google, Yahoo!, and AOL is straightforward: Keep users using. Anything that keeps customers immersed in their products is good for business.

And so, part of the culture of software development has been the freebie. These companies all have deep benches of free services and tools designed to keep

you with their brands. Of course, not all of them are widely known or used. This month, as cash-strapped students especially make their way back to school, we take a look at some of the best free bargains you may not have heard (or forgot) about from the big online powerhouses.

Microsoft Office Compatibility Pack

If you're still saddled with Office 2000/XP/2003, then you no doubt have received files created in the new formats— .DOCX, .XLSX, and .PPTX— that are the standard of Microsoft Office 2007 and 2010. Although older versions of Office can't open these formats by default, if you

have kept your older Office programs fresh with the latest service packs and updates, then you can install the Microsoft Office Compatibility Pack for Word, Excel, and PowerPoint 2007. The Compatibility Pack not only lets you view and edit files made in the newer formats but also lets you save them in the new formats for distribution back to your friends with Office
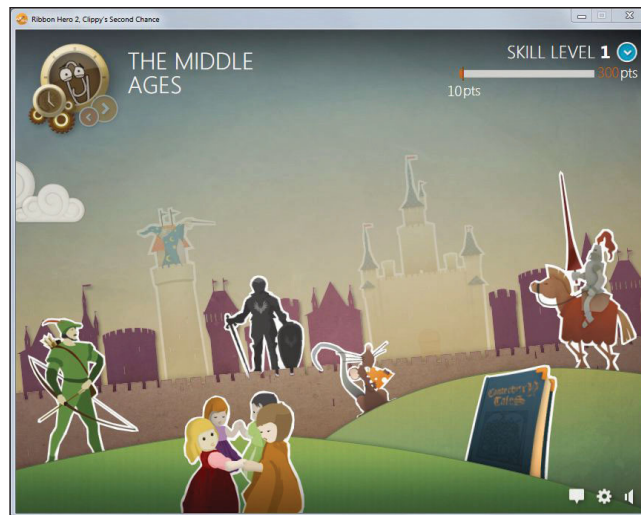
Microsoft brings its much-bemoaned Help mascot "Clippy" out of retirement to host a new downloadable game that helps users of major Office programs discover its new features: Ribbon Hero 2: Clippy's Second Chance.

2007/2010. Complete details are available at support.microsoft.com/kb/924074.

Quick Tip: Microsoft continues to offer Viewer programs that let you view and print (but not edit) Word, Excel, and PowerPoint files on computers that do not have those programs installed. Just go to Microsoft's home page and search for "Excel/Word/PowerPoint Viewer" to find the programs.

The Return Of Clippy

Remember that unctuous animated paper clip that popped up in old versions of Office? Well, "Clippy" is back, this time in an educational game from Microsoft designed to acquaint users of Office 2007/2010 with the new features in the Ribbon interface. The much-loathed cartoon is now the protagonist in

Ribbon Hero 2: Clippy's Second Chance (www.ribbonhero.com).

The program installs an add-in to your PowerPoint, Word, and Excel Ribbons. When you click the option, it initiates an adventure game where you accrue points by completing specific tasks in the respective programs.

Quick Tip: Clippy can be fussy, appearing in some Office programs' Ribbon but refusing others based on your Trust Center Settings. If the Ribbon Hero 2 add-in doesn't appear in your Ribbon, right-click an open area in the Ribbon and select Customize The Ribbon. In the Add-Ins section, you may see Ribbon Hero 2 listed as inactive. Use the Manage drop-down menu at the bottom of the window and choose COM Add-Ins. Click Go, and you may see an unchecked option for Ribbon Hero 2. Check its associated box and try launching the program again.

Google SketchUp

Often overlooked, Google SketchUp (sketchup.google.com) is an amazing 3D modeling powerhouse that lets you design everything from a living room layout to towering office buildings. SketchUp lets you enter exact dimensions for precise modeling. It's available for Windows XP/Vista/7 and Mac OS X 10.5 or later.

Quick Tip: SketchUp is at its coolest when it works in tandem with other powerful Google utilities, such as Building Maker and Google Earth. For example, in SketchUp, click File, 3D Warehouse, and Get Models; then use the search box to look for a famous monument or structure. (We used the Tower Bridge in London.) For the most famous structures, you can download the model into SketchUp to view and even modify to your liking. Combined with Google Earth, you can create more detailed 3D views of buildings shown in Google Earth and upload them for approval to be included in 3D maps.

A New TV Tool For Yahoo!

Yahoo! recently acquired a fascinating TV check-in company that lets you chat with people via your iPhone (look for Android support soon) who are watching the same show as you. IntoNow (www.intonow .com) uses SoundPrint technology to do the check-in for you. Once downloaded into your iPhone, the app can sense what show you are watching from listening to four to 12 seconds of TV audio. The company claims to have indexed 130 channels of live TV and over 2,610,000 individual airings.

AOL's Old Standby

True veterans of the digital media space will recall a day before iTunes and even Napster, when Winamp was the first real building block of the MP3 and digital audio landscape we know today. Now in version 5.6, the very versatile program is still worth a look. It's eminently skinnable, making it one of the most customizable media players out there. Winamp plays most video formats, syncs with iPods and Android devices, tracks your listening history, plays radio stations, downloads lyrics, and can be run from your browser (Internet Explorer or Firefox) via a downloadable toolbar. Don't underestimate the enduring power of the elder statesman of media players. ∎

BY STEVE SMITH

INFINITE LOOP

Megagenius Teenager Builds WMD Scanner

Kids these days. Teenager Taylor Wilson wanted to help in the arduous task of scanning individual cargo containers for nuclear or chemical weapons, so the 17-year-old decided to build a handheld scanner that simplifies the process considerably. Oh, one other teensy tiny detail: Said handheld device relies on a miniature nuclear fusion reactor that Wilson himself built . . . when he was 14. For his effort, Wilson won an Intel Young Scientist Award (plus 50,000 bucks) and a stack of love letters from the Department of Homeland Security.
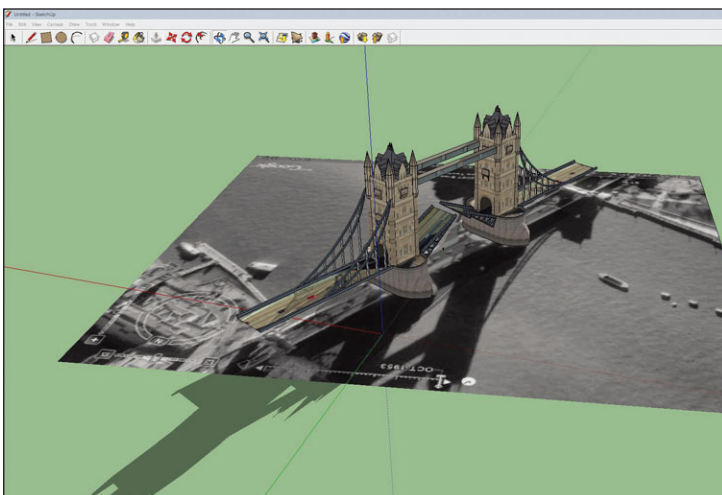
The Google SketchUp 3D modeling program lets you download and modify 3D models from Google's rich world maps.

Warm Up To Penguins

Running A Web Server On Linux

Whether you're looking to establish a Web presence or want to learn how to be a Web developer, a Web server is a good idea. Sure, many people rely on Web hosting providers, but you could very easily set up a small-to-medium-sized Web site yourself and run it on nothing more than a desktop computer. And when it comes to the server software, the open-source community offers a fantastic, and popular, solution: LAMP.

There isn't an open-source project called LAMP. Rather it's an acronym for "Linux, Apache, MySQL, and Perl/PHP/Python." You are, of course, familiar with Linux. Apache is a general-purpose Web server that happens to be the most widely used of its kind. MySQL is an enterprise-ready database that is extremely handy when you're managing complex data. Perl, PHP, and Python are three programming languages that can be used to add advanced Web site functionality.

Several Linux distributions come with Perl installed by default, mostly because there are some low-level Linux administrative commands that are really Perl scripts. And because of the LAMP platform's popularity, its other components are generally distributed on Linux distributions' release media. So, it's often just a matter of installing the parts of the LAMP platform that you want.

The Web Server Foundation

Apache has been the most widely used server software almost since its initial release in 1995. Today, roughly 60% of all

Web servers worldwide run some manner of Apache.

One of the reasons behind Apache's appeal is that it's a good general-purpose Web server. It handles static content that doesn't change often, such

Apache comes with a large set of included modules to expand its capabilities.

as images, about as well as it handles dynamically generated Web pages, making it a good starting point. You can extend its functionality by third-party extension modules that you can dynamically install and remove without impacting the server.

No doubt part of Apache's appeal is its open-source nature, but there's more to its popularity than that. Apache traces its roots to one of the earliest Web servers, the NCSA (National Center for Supercomputing Applications) HTTPd server, which was released in 1993. As a result, many early (and now veteran) Webmasters cut their teeth using it and then migrated to Apache as a result. If the NCSA name sounds familiar, it's because NCSA's Mosaic Web browser was

the early foundation for Netscape, which became Mozilla and then Firefox.

Complex Data Handling

Linux and Apache make a solid Web platform, but unless you're doing the most basic of Web sites you're going to want a database. Databases make it easier to organize and manage disparate and/or complex data and let you access lots of data in lots of different ways. If you're looking for an open-source database, one of the most well-known is the "M" in "LAMP," MySQL.

MySQL is known as a relational database, which means that it matches data it contains by looking at its characteristics. Therefore, a relational database makes it possible for you to group information based on attributes you define. You interact with the data by issuing commands in a language known as SQL (Structured Query Language). It is the language that almost all modern databases understand, including IBM DB2, Oracle, Microsoft SQL Server, and, of course, MySQL.

Don't worry if you don't understand SQL. MySQL's Web site (dev.mysql.com/doc/) is an excellent resource for learning it. All of the SQL commands that MySQL understands and their syntax are available online, for free.

One concern within the MySQL community in recent years has to do with the ownership of the code. For a long time, MySQL was one of the largest open-source companies in the world, with most of its employees working from home. But in 2008, Sun Microsystems

MySQL understands the SQL language, and its Web site provides a great online reference for learning it.

PHP code lives within a Web page, you can lay out the Web page and let PHP change the page's contents. With PHP, you can change the look and feel of a site as much as you want by modifying the HTML stuff, but not touch the PHP code. Doing the same thing with Perl or Python is far more complicated.

As you can tell, you can create a very flexible and powerful Web server for absolutely no money, and without needing to buy server-grade hardware. ■

BY JOHN JUNG

bought MySQL outright. This didn't concern many in the MySQL community, because Sun didn't have any competing products. Indeed, some saw the Sun acquisition as a good thing, because a big-name company was finally backing them.

But in 2010, Oracle bought Sun, and MySQL with it. Not only was MySQL a direct competitor to Oracle's flagship database product, but Oracle itself didn't have the most sterling reputation within the open-source community. Oracle imposes its own licensing model that gives the company ownership of any third-party-contributed code. If you decide to work on MySQL and improve it, your changes and improvements partly become the property of Oracle.

But regardless of how you feel about the ownership of the underlying code, the fact remains that MySQL is a powerful free database.

Programming For Web Pages

Even with a database, creating truly complex and dynamic sites requires a programming language . . . or three. As noted earlier, the "P" in "LAMP" can stand for any of three popular languages—Perl, PHP, or Python. All of them are quite capable and can be used for Web development, but each has its own strengths and weaknesses.

Perl is a scripting language that comes with most Linux installations. It has a massive library of existing modules and is highly regarded for text processing, so it's well suited for Web-related work. But one of the biggest drawbacks with Perl is that its syntax can be rather cryptic and confusing if you're an occasional programmer.

Python is similar to Perl in that it's a scripting language, but it's far more readable and easier to learn. Readability is an important factor with Python because it's actually designed to be read a certain way. Most other programming languages don't care how you indent code as long as you write the correct syntax. Python does, however, and won't work correctly otherwise. Programmers who may take code formatting shortcuts with other languages won't find Python as forgiving.

Quite unlike Perl and Python is PHP, which is a language that's primarily designed to be run by the Web server. That is, the Web server has a PHP interpreter (as scripting languages, both Perl and Python require their own interpreters) built into it, so that as the Web server is sending out Web pages it can do computational work. This allows Web pages to do different functions based on the input from the user.

This distinction is significant, because although Perl and Python can handle data from Web browsers, sending the processed result back can be tedious. That's because Perl and Python scripts have to build the entire response to a user's input, which means creating a Web page and all the HTML tags. But because

Duck Hunt's Long-lost Ancestor Found

Light gun videogames have carved out a long and storied niche in the gaming world. Games like Big Buck Hunter, Time Crisis, and Lethal Enforcers can trace their roots back to the venerable Duck Hunt. Now, videogame anthropologists have unearthed what has to be the Cro-Magnon of all light gun shooters. Behold: Ray-O-Lite, which requires you to set your time machine to 1936. Developed by Seeburg, the 75-year-old coin-op game is everything a Depression-era version of Duck Hunt should be, right down to the shotgun-style light gun and analog waterfowl trying desperately to escape a buckshot demise.

Source: www.freegamesden.com/blog/duck-hunt-was-actually-invented-in-1936/

Open-Source Hardware

An Introduction
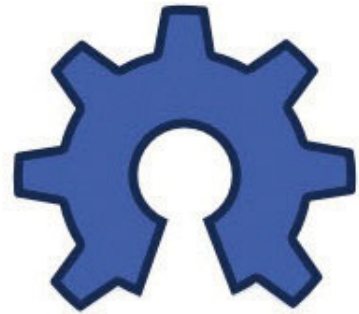
As of this spring, the OSHW (Open Source Hardware) movement has its own logo.

Open-source software is a heavily documented and discussed phenomenon—see, for example, the very monthly article you're currently reading. But a companion field, open hardware, is growing quickly and presents some intriguing possibilities for technology both today and in the future.

What Is Open Hardware, Exactly?

The Open Hardware Summit (www.openhardwaresummit.org) has produced the OSHW (Open Source Hardware) Statement Of Principles 1.0 and the OSHW Definition 1.0, a set of general, high-level guidelines regarding the ideals and standards of the open-source hardware movement.

The proposed OSHW Statement Of Principles 1.0 is hosted at freedomdefined.org/OSHW and states, in its entirety:

"Open-source hardware is hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design. The hardware's source, the design from which it is made, is available in the preferred format for making modifications to it. Ideally, open-source hardware uses readily-available components and materials, standard processes, open infrastructure, unrestricted content, and open-source design tools to maximize the ability of individuals to make and use hardware. Open-source hardware gives people the freedom to control their technology while sharing knowledge and encouraging commerce through the open exchange of designs."

The OSHW Definition 1.0 is much lengthier and includes parameters for documentation, scope, necessary software, derived works, free redistribution, and attribution. It also posits a position on non-discriminatory practices against people, groups, and "fields of endeavor," such as businesses or research teams in various fields. There are also several items pertaining to licensing, including distribution; removing restrictions on specific products or hardware and software; and ensuring that licenses are technology-neutral, meaning that it can't be dependent on specific technologies, components, materials, and so on.

Of course, that's just the clinical definition. Many of us had some version of an electronics kit when we were kids. You know the ones—you could tinker with dozens of different electronics projects using the various tools and parts. It all came in a literal cardboard box but was a veritable Pandora's box for us youngsters and our unlimited imaginations. Open hardware is in many ways a bigger, badder, cooler version of that.

Practicalities

Open-source hardware is based on the same basic ideals as open-source software, but there are obviously some major practical differences between the two.

For one thing, distributing software is very easy to do and costs the distributor basically nothing. You can post your software online, and others can download, install, and start using it (and/or add to it) in minutes. Further, when someone allows another party to acquire a piece of software, the distributor still has possession of the software; it's just been multiplied.

Hardware is a totally different story because it is physical material. You can't just download it with a click, and even if someone wanted to give it away, they'd lose possession of the actual object.

Thus, open hardware has more to do with making designs, schematics, lists of required materials, and the necessary software and firmware freely available as opposed to handing out an actual finished product. Of course, collaboration is still a key tenet of open-source hardware, and that can take many forms, from the nitty-gritty of schematics to finding new ways to put together open components to create new products.

However, there are also plenty of kits, parts, and components available from a variety of manufacturers. These items include circuit boards, processors, and more.

Some tech companies have discovered that it's financially wise to open-source some of their ideas and components. For example, if a company sells a certain kind of processor, it behooves them to let others use their schematics and designs for, say, a computer, because then they effectively

sell more of their processors. Further, if a company makes a design freely available, people who want to build the project need to buy components from that very same company.

Open-sourcing their intellectual property also helps drive innovation, which inevitably comes back around to them in the form of new customers attracted to the lower cost of entry. And, of course, it acts as a magnet to the horde of garage-and-basement tinkerers and DIYers who will want to use those products to build their creations. In short, everybody wins.

There are already a number of examples of open-source hardware products, from the aforementioned component-level kits and parts to full-fledged products such as tablets and notebooks. In between, you'll find gadgets like clocks and RC toys, as well as MP3 players, calculators, all manner of sensors, and so on.

3D Printing

Back in 1999, Richard Stallman went on record with his thoughts on open-source hardware and mentioned the problem of being unable to download hardware from the Internet. He did not (or could not) foresee the possibilities of 3D printing.

3D printing is a developing field that lets you take information regarding a physical object and produce it with a machine that uses physical matter instead of ink to "print." It's like having a tiny manufacturing facility in your house.

3D printing is a whole other ball of wax (although there are plenty of DIY plans available for making one's own 3D printer), and innovation in that sector is dazzling. Theoretically, you can "print" anything, provided you have the raw materials available, a machine capable of producing the item in question, and the proper data that the machine needs.

Photo by the Arduino Team

Companies such as Arduino (www.arduino.cc) produce open-source hardware and give away all of their intellectual property so the community will innovate and make their products better.

Because plastics are some of the easiest materials to work with at the moment, printing plastic items is common. Even so, people are already printing everything from widgets to handy household items such as bathtub drain plugs. Some machines can print parts that are used to build the printer in the first place, and thus there are 3D printers that are technically self-replicating.

Combined with the rapid proliferation of open-source hardware enthusiasts, it's just a matter of time before the twain shall meet, as it were. How soon until I can print a processor, motherboard, or game controller from a $1,000 machine on my desk in the basement?

Sky's The Limit

The concept of open hardware is certainly compelling; in a technology landscape where you can do almost anything via the open Internet with free and open applications, operating systems, and services, we're still completely locked in and beholden to hardware makers.

You can create essentially anything you can imagine on a computer—make music, art, poetry, prose; build world-changing social networks; run a business from anywhere in the world with anyone in the world; create, launch, and maintain Web sites; make your own software; and much more. This is not to mention what you can do with a smartphone.

But you can't do any of the above without first buying a piece of hardware from some company. Your options are, by comparison, laughably limited. How tantalizing is the prospect of being able to create (by building or printing) and customize your own hardware to your own needs and specifications? How would/will that change the landscape of technology?

In the early '90s, Linus Torvalds and a gaggle of other forward-thinking engineers were faced with essentially the same issue: They didn't want to be limited to what few operating systems were available at the time, which were all closed and proprietary, and furthermore they thought they could do better. We all know how that turned out. (Hint: Very, very well.) Some of the greatest technological innovations of the last 20 years were built on the back of that work.

The same could possibly happen with open-source hardware, for the same reasons open-source operating systems, programming languages, and software have been so successful. Here's to all the hackers, tinkerers, hobbyists, and innovators that will continue to push these developments forward. ▲

by Seth Colaner

THE WITCHER 2
ASSASSINS OF KINGS

No-Compromise PC Role-Playing
—by Dr. Malaprop

$49.99 (PC) • ESRB: (M)ature
Atari • thewitcher.com

The two Witcher games released to date are based on the world created by fantasy author Andrzej Sapkowski in his Witcher saga. Both games are heavily dependent on narrative, so we'll minimize plot details to avoid spoiling the story.

Assassins Of Kings finds Geralt of Rivia picking up a mere month after the dramatic and shocking conclusion of the original 2007 game. The game opens in the prologue, which is out of sequence in the storyline but introduces players to the game. Think of it as a trial by fire. Take your time, be methodical, and work your way through it. However, regardless of your success, you are framed for the assassination of the king and are outlawed.

As in HBO's "Game Of Thrones," you'll encounter warring races and constantly shifting politics. Decisions made resonate later, resulting in your not being able to see parts of the game in a single playthrough that should last at least 40 hours without delving too heavily into side quests. A second playthrough will yield a substantial amount of previously unseen game content. Gameplay is more action-oriented than the original, and preparation for battle is essential to survive. Except at the easiest difficulty, expect death often until you've invested the effort in upgrading your character and learning the nuances of combat.

The original Witcher game, based on a massively modified Neverwinter Nights engine, was not jaw-dropping. However, PC gamers with powerful rigs are in for a spectacular surprise. The Witcher 2 is one of the best-looking PC games available. The beauty is in the high level of detail that brings the world to life. And the clincher is the comparably excellent sound design, which brings the characters and environments to life. Muting the audio while playing would be criminal; this is a game you must see and hear to enjoy the full effect. If there's better to be had today, it doesn't spring immediately to mind.

Role-playing games have suffered heavily from "consolification" in an attempt to reach a broader audience. It's rare to find such a polished RPG that appeals to experienced gamers and pulls no punches in gameplay or narrative. Gameplay here is both challenging and highly rewarding. It's the kind of uncompromising game design we'd like to see more games adopt. That said, having a more helpful and engaging tutorial would have been welcome to help ease into the game.

As we went to press, developer CD Projekt RED addressed player complaints by releasing the v1.3 patch. Changes include the softening of the difficulty curve in the game's prologue, a new quest in Chapter 2 called "A Sackful Of Fluff," improved inventory storage, and support for additional aspect ratios. Furthermore, the patch also addresses game and mission bugs as well as criticisms regarding the previously onerous inventory system. Game menus are less intuitive than they should be and can stand to be streamlined. This shortcoming in no way prevents the game from being highly enjoyable at the superset level. More details on the patch are available at thewitcher.com/patch1-3, and console gamers can take solace in knowing that a release is coming to Xbox 360 later this year. The Witcher 2 is our AAA surprise of 2011 that holds its own and arguably reaches beyond the likes of Dragon Age II and Mass Effect 2. ▲

F.3.A.R.

Well Beyond Its Origins—*by Dr. Malaprop*

Developer Monolith Productions put out its hybrid horror-themed FPS called First Encounter Assault Recon, or F.E.A.R., in 2006. It was genuinely creepy with memorable enemy AI that worked in unison to flank and flush the Point Man from cover. The 2009 sequel continued the saga of the supernatural rage-filled Alma Wade but focused on a different protagonist.

F.E.A.R. 3 brings us back as Point Man and introduces us to his telepathic sibling, Paxton Fettle. Upon completing any level as the Point Man, you can go back and replay it again as Fettle—scarred appropriately from the damage you dealt him in the first F.E.A.R. Playing through as Fettle is far more interesting than as the generic, gun-centric Point Man. Fettle's abilities to deal heavy swaths of damage with telepathic powers, which include possessing enemy soldiers, never ceased to be a pleasure.

As with the prior F.E.A.R.s, you have a linear path with heavy firefights and occasional calm moments set aside to bring the scary ambiance. Level design was unintuitive, and we occasionally found ourselves wandering aimlessly, looking for an exit. We generally prefer campaign co-op (both split-screen and online supported), but that pleasure sacrifices the chills less stoic gamers may experience. So if you're looking to be scared, our suggestion is to play through solo.

The graphics in F.E.A.R. 3 are passable and forgettable. Audio cues do create a tense ambiance, but sometimes having less can be more effective. Multiplayer modes support up to four-player co-op along with competitive modes, but they're the reason you'll buy this title. F.E.A.R. 3 is more of the same. It will entertain fans of the genre, but it's ready to retire. ▲
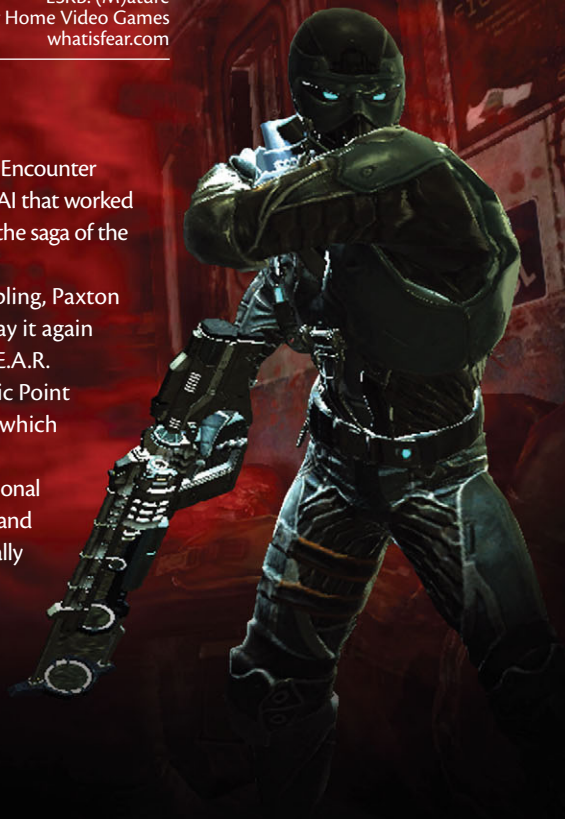
DUNGEON SIEGE III

Jeyne Kassynder Is Bad, Mkay?
—*by Chris Trumble*

Dungeon Siege III, developed by Obsidian Entertainment and published by Square Enix, borrows some elements from its Gas Powered Games/Microsoft Game Studios-bred predecessors and eschews others. For example, DSIII retains your ability to customize how the various playable characters develop as they gain experience, which is cool, but it cuts the size of your party from a max of six characters to two active members.

Eventually, you'll have access to all three companion characters; you can swap them in and out at will, and the various combinations of combat types provide a nice amount of gameplay variety. The game's multiplayer options open things up a bit; you can play two-player local co-op or have as many as three people join you online.

The story offers differing intros and occasional unique companion encounters depending on which character you choose at the outset, but it doesn't change substantially. You are the descendant of a member of the mostly extinct 10th Legion. Your goal is to end the threat of the fanatical Azunite Church's army (you may tire of hearing how positively evil its leader, Jeyne Kassynder, is), which exterminated the last generation of legionnaires and is currently threatening to do the same to the kingdom of Ehb's royal family.

The game looks nice and sounds great. We like the variety of loot you acquire along the way, and DSIII's equipment comparison interface is a shining example to the RPG industry. Our only technical complaint has to do with the PC version's controls. We spent the first three or four hours fighting DSIII's unfortunate keyboard and mouse configurations and never really became comfortable with them. At press time, there was no option for customization.

We didn't find this to be the case with the Xbox 360 version, which felt intuitive and had us adventuring at full speed in minutes. Hopefully, Obsidian will have the opportunity to patch the PC version because once you get past this issue, Dungeon Siege III has some good times in store for you. ▲

TRENCHED

A Mech By Any Other Name—*by Dr. Malaprop*

With the release of Costume Quest, Stacked, and now Trenched in a fairly short window of time, it's clear that developer Double-Fine is leveraging gameplay systems from its very own Brütal Legend, which was such a blend of genres. Of its three smaller, downloadable games, Trenched is our favorite.

"The enemy crushed my legs, but he couldn't crush my spirit. And he couldn't stop me from serving my country." That's a quote from the opening scene of Trenched. As part of the Mobile Trench Brigade, you are called upon to defend the planet from the Monovision as it strives to enslave the Earth in an alternative post-World War I timeline. The game combines third-person mech combat, strategy, and tower defense mechanics in campaigns that span Europe, Africa, and the Pacific.

In the single-player game, combat is relentless, with waves of enemies always on the attack. It's fun piloting a powerful mech, but it's really a glorified tower defense game—not extraordinary. This perspective changes dramatically if you call in up to three more friends for co-op gameplay (split-screen not supported). Suddenly, dishing out strategy over your headset on tactical locations, turret placement, and the like makes Trenched feel more alive and improves the game dynamic exponentially.

Playing a mech combat game is fun and easily worth the $15 (that's 1200 Microsoft Points) price of entry, but with friends in tow, Trenched is easily worth twice that for the shared, gleeful gameplay experience. ▲

ALICE MADNESS RETURNS

Down The Rabbit Hole We Go—*by Dr. Malaprop*

We experienced American McGee's Alice when it released on the PC in late 2000. Drawing inspiration from Lewis Carroll's "Alice's Adventures In Wonderland" book, the original Alice was a third-person action platformer that creatively incorporated characters from the novel and introduced us to a fantastically warped Wonderland. New copies of the console game include a code to download the original game . For those who don't have a code, it's available for $10 via Madness Returns. In that game, we learn about the tragedy of Alice losing her family in a house fire. As the game concluded, Alice was released from the mental asylum.

Madness Returns picks up shortly after the first game's conclusion with Alice as a resident of a depressing Victorian London orphanage under the watchful eyes of a psychiatrist. When Alice leaves to visit a chemist, she tumbles down the rabbit hole and begins the first of the game's five chapters. The game is a thematic exploration of Alice's fragile psyche and delves into the depths of her sanity.

Madness Returns features enjoyable level design along with exquisite texture and lighting effects wrapped around a mélange of dark and delightful artwork inspired by the book. Combat mechanics are simple by modern standards. Puzzles and objectives are simple, and jumping to your death bursts you into an explosion of blue butterflies that return you to the living.

Ultimately, Madness Returns feels too long. It has visuals in spades, but the core game mechanics feel sparse. We'd almost rather watch it being played instead of indulging ourselves. ▲

DUKE NUKEM FOREVER

$49.99 (PC); $59.99 (X360, PS3)
ESRB: (M)ature
2K Games
dukenukem.com

We'd Rather Chew Gum—*by Dr. Malaprop*

This sequel to 1996's much-loved Duke Nukem 3D was announced in 1997 and finally released *14 years* later in June. The earlier Duke games lived by their own crass tongue-in-cheek charm and were very much a product of their time. Duke Nukem Forever, however, replaces that charm with offensive content delivered via uninspired level design, outdated FPS mechanics, and loose controls. It's a cringe-worthy experience.

Unfortunately, Duke Nukem Forever lacks imagination and drags its namesake franchise down. The game's journey to release is better entertainment than the end-result. The only justifiable reason to pay the price of entry is akin to not being able to look away from a train wreck. Instead, to enjoy a game that captures the irreverence and over-the-top pop culture mannerisms of the Duke franchise, pick up EA's Shadows Of The Damned, which embraces the tropes we loved in early Duke Nukem fare. ▲
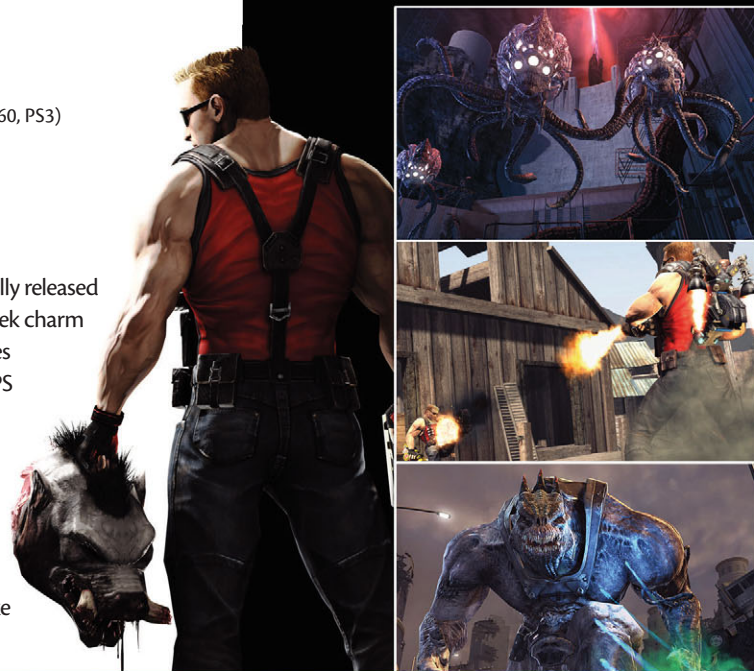
XFX WarPad—*by Josh Compton*

XFX WarPad • $54.99 • XFX
www.xfxforce.com

Mousepads are the unsung heroes of the PC gaming world. You may not always think about it, but the ability to glide your mouse smoothly and comfortably across your desktop can often be the difference between success and failure. The XFX WarPad is a gaming mousepad that provides support and comfort for intermediate and professional gamers alike.

The first thing you'll notice about the WarPad is that it takes up quite a bit of space. Measuring 16.97 x 13.98 inches, it's definitely one of the bigger mousepads we've ever seen, but its form does have a function. The larger playing surface means that your mouse won't run off the edges and you'll be able to focus on the task at hand. The size also gives you the option of setting your entire forearm on your desktop for better support. And if you are a professional or competitive gamer who attends LAN parties or other events, don't let the size deter you because you can roll up the WarPad and store it in a bag or backpack when not in use.

The most important feature of the WarPad is the clamp near the bottom, which serves a dual function. It fastens the mousepad to your desk so there is less movement during gameplay. And the second is what XFX calls the Edgeless Support System (ESS), which extends past the end of your desktop and rounds off the edge to prevent discomfort or injury to your elbows and arms during longer gaming sessions. The clamp itself can be attached to desks that are up to 2 inches thick.

The XFX WarPad is great for any level gamer. It is five times larger than an average mousepad and about twice as thick, which means a larger playing surface and better overall comfort. ▲

Cooler Master Storm Sirus Gaming Headset —*by Blaine Flamig*

Specs: Headset: Impedance, 32 ohms front, right, and center and 16 ohms sub; sensitivity, >105dB; frequency response, 10Hz to 20KHz; Microphone: impedance, 2.2k ohms; sensitivity, -46dB ± 3dB; frequency response, 100Hz to 10KHz

Storm Sirus Gaming Headset
$129.99
Cooler Master
www.cmstorm.com

All cards in. That's how Cooler Master has saddled up to the gaming headset table, laying down a true 5.1 surround-sound circumaural offering called the CM Storm Sirus.

Sirus' 5.1 approach packs front, rear, and center speakers, each with a 30mm driver and a sub with a 40mm driver, into each earcup. The earcups sport comfy micro-fiber cushioning, but you can swap them out for the leather-based cushions also included. You also get two cables, one with four analog jacks and a USB connector and another with two USB connectors. The dual-USB cable integrates a sizable saucer-shaped Tactical Mixing Console with a huge volume knob that doubles at tweaking each channel individually in real time. Overall, the implementation is slick. Sirus' Tactical Software Console provides additional, albeit basic, fine-tuning options (individual channel adjustment, 10-band equalizer, environmental effects, bass enhancement, etc.). The flexible, unidirectional boom mic performed admirably and offers noise cancellation and an LED mute indicator. Initially, the headset felt heavy but wore lighter than I expected.

Across movies, games, and music, Sirus provides clear, lively audio. Its sub does lean toward being underpowered, but surround-sound performance was a treat, to the point that merely wading through water in Left 4 Dead was sloshingly impressive. Sounds like Cooler Master is holding a winning hand. ▲

Locker Talk

## Your Music Library Takes To The Cloud

No single media industry has been so thoroughly disrupted by digital technology as music. From the days many of us first learned how to rip a CD, used Winamp to play MP3s, watched iTunes' 99-cents-per-song model deconstruct countless albums, or streamed music through Pandora, computers and the Web have redefined the listening experience and the music economy.

Despite record labels' devotion to physical media, retail stores, albums, and high prices, consumers continue to drive the market toward cheaper, more flexible solutions. The next stage in that evolution unfolded this spring, as three of the biggest entities in the digital domain—Amazon, Google, and Apple—almost concurrently unveiled their respective plans to make all of a consumer's music accessible whenever and wherever, courtesy of the cloud. In Amazon's Cloud Drive/Player, Google Music, and Apple's iCloud, the music lover gets access to his or her own tracks from any PC and from various connected devices, including smartphones and tablets.

Now, the battle for the music market takes to the cloud. But what are these new services, and on what heavenly terrain will these and other competitors battle for consumers' hearts and minds (and money)?

A Drive Through Amazon's Cloud

Of the three high flyers in cloud music service, Amazon was the first to take flight; as of this writing, it's the only one widely available. Current
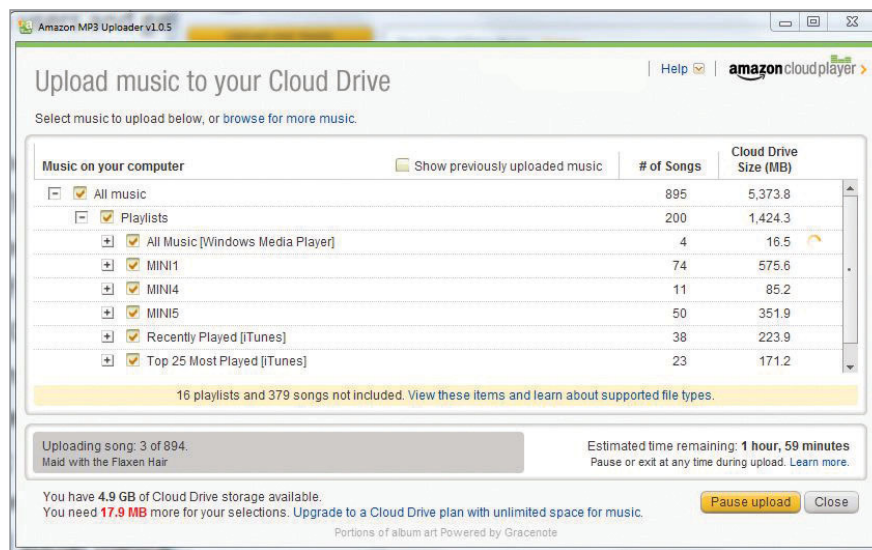
Amazon's Cloud Drive scans your PC for music tracks and playlists, which it then uploads to its servers for access from any Web browser or Android device. Uploading hundreds of tracks can take hours, however.

Amazon customers can simply go to the Cloud Drive site (www.amazon.com/clouddrive) and set up 5GB of storage free. The service accepts more than music and has folders for videos, images, and documents. We gave Cloud Drive a try to see what the advantages and limitations of music in the cloud might offer.

For music file management and playback, you'll want to move to Amazon's dedicated Cloud Player (www.amazon.com/cloudplayer), which gives you a Web-based interface. When you upload music to your Amazon player, a pop-up window scans your system's hard drives for compatible (MP3 and AAC) music tracks. The scan we ran in

our test found nearly 900 songs totaling 5.3GB. This list included all of our iTunes libraries except tracks with DRM protection, and this included a number of CD rips we had made into iTunes. Although several hundred of our DRM-restricted tracks didn't make the upload, Amazon did find and re-create our 16 playlists online.

The downside of the Amazon model is upload time. It took hours of background uploading to get the tracks into the cloud on a 6MBps upstream connection, and it likely will take much longer on normal home connections.

Once the tracks were uploaded, we were able to navigate to and access the Cloud Player from any Web browser (including Safari on an iPad) and from within the Amazon MP3 Player Android app. You can navigate the playlists and stream music to your device or browser at the bit rate of the original track. It's also easy to create new playlists on the fly

> Of the three high flyers in cloud music service,
> Amazon was the first to take flight; as of this writing,
> it's the only one widely available.

and upload tracks from the local device back to the Cloud Drive. And although Amazon emphasizes its ability to stream your music from the Cloud Player to many devices, on the Android and Web platforms you can also download your track onto the new device for offline playback. For those looking for general storage, it should be noted that the Cloud Drive also lets you view (but not edit) the documents, images, and video you've uploaded from other machines. You could, however, download a local copy, edit it, and re-upload it.

Of course, Amazon is in the business of making money, not giving away freebies. We fit about 300 tracks in the 5GB of free space the Cloud Drive made available, but beyond that, we would have to buy a $20 per year plan for 20GB of storage. (Larger paid plans are also available, all at $1 per gigabyte per year.) Under the free plan, Amazon would give you unlimited space for any track you purchase from Amazon itself. In the end, the cloud music model is about selling more tracks.

Amazon has landed in some hot water with music labels over this "music locker" model, because the retailer didn't speak with the music industry about revising existing licensing agreements to cover this new mode of storing and redistributing licensed material. Amazon insists that Cloud Drive just stores media the user already owns. The company told media outlets, "We do not need a license to store music in Cloud Drive. The functionality of saving MP3s to Cloud Drive is the same as if a customer were to save their music to an external hard drive or even iTunes."

Google Gives It Away (For Now)

Soon after Amazon's Cloud Drive/Player launch, Google rolled out its worst-kept secret, a similar locker dubbed "Music Beta by Google." As of this

Even before its official release with the iOS 5 upgrade, the Apple iCloud model is already evident in the App Store app on iPhone/iPad/iPod touch, where users now can re-download any app from the cloud that they previously purchased.

writing, the beta was invitation-only. Like Amazon, Google scans your system for music files, including iTunes libraries and playlists, and uploads them to the cloud. However, Google is, for now, letting beta testers upload up to 20,000 tracks (typically much more than 5GB of space) at no charge. Music Beta also handles
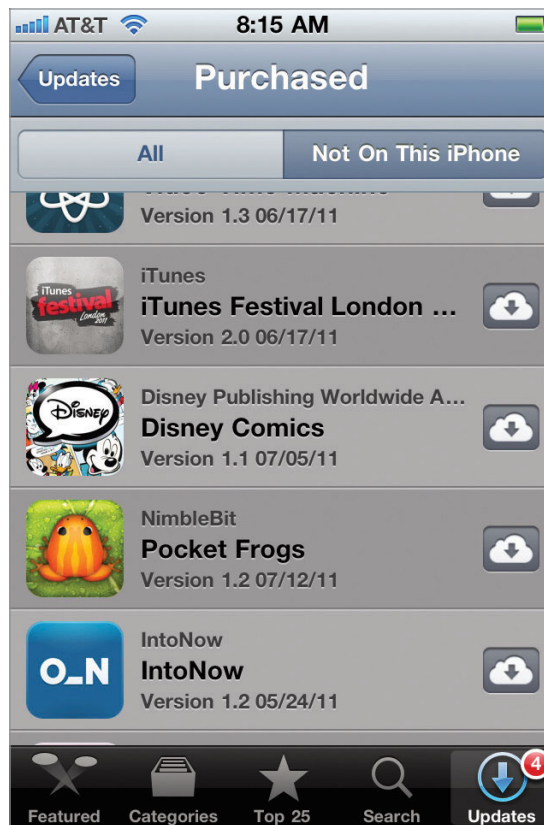
WMA and FLAC formats on top of AAC and MP3.

But unlike Amazon and Apple, Google doesn't sell music (currently, at least) to consumers through Music Beta. The company says it will determine a pricing model for its storage and streaming service later, but ABI research analyst Aapo Markkanen says that the search engine's cloud music strategy is about keeping users within Google Land.

"Google wants to maximize the number of users in its service ecosystem, and a music service is just another attraction," he says. "The larger the ecosystem, the larger the advertising potential of that ecosystem."

The Google plan is also about enhancing the value of its Android-based smartphones and tablets. The music you upload to the service will be accessible via an app in the Android Marketplace. Android users will also get more flexibility from Google than from Amazon, in that the Google Music app will keep the recently played tracks on the device in addition to letting users choose artists, albums, and playlists to store locally for offline listening.

Apple Thinks Differently

In early June when Steve Jobs took to the stage at Apple's annual Worldwide Developers Conference, his iCloud was coming into the game after Amazon and Google had made their moves. He chided the competition, saying "Some people think the cloud is just a hard disk in the sky. . . . We think it's way more than that." With iCloud, Apple's vision is to move away from the desktop computer as the center for storing and

Amazon has landed in some hot water with music labels over this "music locker" model, because the retailer didn't speak with the music industry about revising existing licensing agreements to cover this new mode of storing and redistributing licensed material.

distributing your content. "We're going to demote the PC and the Mac to just be a device. And we're going to move the digital hub, the center of your digital life, into the cloud," Jobs added at WWDC.

In practical terms, that means iCloud has automated operations to keep devices in sync so content you upload is automatically pushed out to your iPhone, iPad, PC, Mac, and so forth. And the range of content is broader than most. The iCloud product, slated for launch in the fall, will synchronize email, calendars, photos, books, apps, etc., across devices.

The standard iCloud access plan will give users 5GB of free storage and doesn't count Photo Stream images or any iTunes music, books, and apps purchases against that total. An upgraded service, for $24.99 a year, will give users unlimited iTunes storage for music files. iCloud functionality will be part of the upcoming iOS 5 and an upgrade to iTunes, but iPhone, iPod touch, and iPad users can see part of iCloud in action now in the App Store app on their devices. In the Updates tab of the App Store, users can re-download all of the apps they have purchased in the past.

Music stored in iCloud will work on a different model from Amazon or Google's pure locker approach. Rather than having to upload your existing music library to the cloud, you let Apple scan your local iTunes library and find in its own catalog of 18 million tracks the same song and keep that in the cloud for redistribution to your other devices. The system is called iTunes Match, and it seems to have evolved from startup company Lala, which Apple acquired in 2009. Lala had been a streaming music service that sold rights to stream a song over the Web for 10 cents a track. But if Lala found that you had already purchased the song, it let you stream it without charge. Apple matches the tracks you own against its own catalog, but unlike Lala and even Amazon and Google's music models, iCloud isn't offering streaming. iCloud will download music to the various Apple devices, but it will also upgrade the tracks to Apple's own 256Kbps version that is also DRM-free. Apple has pulled off this feat because it negotiated licensing deals with the major labels to allow for the redistribution of their content in this way.

As J. Gerry Purdy, principal analyst for market research firm MobileTrax, points out, the iCloud approach is more efficient but closed. "It only works for Apple products and not for others," he says. iCloud music can play on a PC but only through iTunes, not Web browsers. As you might expect, iCloud is out of the picture for Android device users.

But overall, in this coming battle in the cloud, Markkanen feels Jobs & Co. enjoy advantages.

"Apple is the strongest of these three, because it has the labels on its side. That allows them to run a central database that includes all licensed songs, and the users don't need to upload their tracks to the cloud. Between Google and Amazon, Amazon may have the edge because it actually sells music and has thus integrated its locker with the store."

The truth about music's future distribution models may not be in the cloud so much as it will be among consumers. As we move into the fall months, with iCloud launching and Google Music coming out of beta, the decision over which cloud to land on will be ours. ▲

BY STEVE SMITH

The Music Industry Downgrades Again

According to Aapo Markkanen, mobility expert and industry analyst for ABI Research, the music labels may gripe about the new cloud models, but ultimately they serve consumer needs and may represent the best-case scenario for the future of the industry.

CPU: Do consumers really want cloud-based services?
Markkanen: People have typically been very keen to listen to music outside their homes, be it via radio, portable media players, or MP3-capable mobile phones. Cloud music services just add another layer of mobility to the principle.

CPU: How does this next stage of the digital music story further impact the music industry itself? Is this another disruption to their distribution and business models?

Markkanen: If you compare cloud music to the predigital era, it's of course a downgrade for the record labels. Labels had far more control over the value chain back then. If you liked two or three songs from a certain album, they made you pay for a dozen others—regardless of your interest in them—and that reflected on their profits. However, compared to an alternative reality where the most convenient digital music offerings would be illegal ones, it's an obvious opportunity for them.

I'd argue that record labels have been destined to go through a phase of overall downsizing, and cloud music services are probably their best shot to make that downsizing as controlled as possible; it's a bit of a necessary evil in that sense. Then again, you can also take another perspective: aspiring artists. For them, the physical distribution of music always meant a serious barrier of entry into the music business because the distribution channels were so restricted. With cloud-based distribution, those barriers, and the risks associated with them, are far lower. In that sense, this shift is also a shift of power from gatekeepers of the content to its suppliers.

CPU: Are there other services consumers should consider beyond the big three?
Markkanen: Internet radio services with good recommendation engines, like Pandora, are also worth following. Their main advantage against lockers (Apple, Google, Amazon) is the opportunity to constantly discover new music. With lockers, you're limited to songs that you already possess. ▲

An Interview With
Nvidia's Nick Stam & Sridhar Ramaswamy

NICK STAM joined Nvidia in early 2005 as a technical marketing director. Prior to that, he worked for Ziff Davis as lab director and technical director of PC Magazine for nearly 14 years.

SRIDHAR RAMASWAMY joined Nvidia as a senior marketing manager in October, 2007, and is currently responsible for technical marketing of the Tegra product line. Sridhar has more than 10 years' experience in the PC semiconductors industry.

BY BARRY BRENESAL

CPU Let's talk a bit about the background of the Tegra line, and the move from Tegra 1 to Tegra 2.

NS Tegra 1 was our first attempt at getting into the mobile device market. It was very good, and in some ways ahead of its time. You saw it in the Microsoft Zune HD and used by Samsung and a few others, too. But the problem was its operating system. It just didn't have a stable, well-developed architecture from an OS perspective, so we really didn't have a strong software foothold.

For Tegra 2 we worked closely with Google, and many hardware vendors took early versions. There was a lot of effort put in, and in late 2010 we began to announce OEM partnerships.

Now, with the combination of Tegra 2 and the Android OS, we have an environment that works well. It's the first dual-core, ARM-based system-on-a-chip to come to market, with products that started showing up in the early part of the year. The first phones and tablets emerged in quantity in February and March, including the Motorola Xoom tablet and the Atrix 4G and LG Optimus 2X superphones, etc. Others have appeared since then.

CPU Returning to the differences between the two Tegra chipsets, what are those at the architecture level?

SR The Tegra 2 CPU is a Cortex A9, while the Tegra 1 was a Cortex

A8. Each core runs at 1GHz, with its own L1 cache and a shared L2 cache. We have dedicated cores for video encoding/decoding and image processing. In addition, a small ARM7 shadow processor takes care of all system management when the main processor needs to be shut down to avoid consuming power for a relatively small task. In addition to the CPU, we have the GeForce architecture-based GPU in there.

NS It depends on how you look at graphics architecture, but these are four floating-point units for pixel and four for vertex processing: we call that eight cores. The graphics side of the chip is more of a classic architecture that's been heavily modified for mobile usage. Thus it has many caches and prevents going off-chip as much as it can, since that consumes more power.

CPU Power is an issue that's come up in a number of contexts. Part of the single-core mystique

is that a faster chip will outperform a slower dual-core at a single task. The Tegra 2 is clocked at 1GHz.

NS But they can be clocked down based on the task that is running for lower battery consumption. What's more, if the task is multithreaded, then you can run both cores at a lower clock rate and attain higher performance while consuming less power than a faster-clocked single core.

SR There are many levels of power management built on the chipset. At the system level, if the CPU's not being used, the frequency is brought all the way down to zero, and it's power-gated. When blocks within a core are not being used, we turn off those cores. We have even finer-grained control; if we see registers in data paths that are not being used often, then we clock-gate those.

CPU So power management is a major reason for the chipset's success. What else is it about Tegra 2 that makes it popular with developers?

NS Access to premium content is another big differentiator for Tegra 2. For example, if you go to our Tegra Zone application in the Android Market, we have many games enhanced for Tegra 2, with still more on the way.

The thing about our architecture is that developers know how to develop for the OpenGL pipeline. Ours is more "classic" programming for them, so it's a little easier to port the console and PC gaming titles.

Also, we do faster geometry processing. Developers tell us they can get two to three times the geometric complexity in their environments, characters and objects, using Tegra 2, compared to other devices.

Some of our competitors claim they're going to squash Tegra 2 because they're newer and better—but many of the reviews have shown this not to be true. Tegra 2 holds its own and excels when it comes to mobile gaming.

CPU What is it specifically about the development of the Tegra line that you feel lets you get better results than your competition?

NS It has a lot to do with software. We have a tremendous amount of talent from the years Nvidia's been in graphics and video processing in particular. Other companies lack this legacy and extensive background, and their software solutions (including operating system-level tools, drivers, game optimizations, and device-level programming) appear to not be as effective.

SR I would add that it's not just about the chip; it's about the user experience. We've been working with game developers on the PC side for more than a decade. The same developers are now creating games on the mobile side, and we are leveraging our unique relationships to bring similar experiences to the mobile environment.

NS So be on the lookout for more Tegra 2 products to come out, before the next generation of the chipset hits.

CPU That's a good segue to discussing Kal-El.

NS At Mobile World Congress 2011, we announced limited information about Kal-El and cannot say much more at this time. We can reiterate that Kal-El will come equipped with four ARM cores and 12 GPU cores, and performance specs will be roughly two to five times faster than Tegra 2, depending on the task being conducted. For certain computing algorithms, we've seen up to 5x improvements. Games are generally 2 to 3x, and in multitasking scenarios you'll see a number of speed-ups, as well.

We have a demo called Glow Ball that's on the Web now, with a lot of hits. It walks through a number of new graphical features: dynamic lighting, some really great physics, reflections—the kind of effects you'll see on desktop PCs, but that can now be seen on portable devices. The video demo, which is quite popular on YouTube, illustrates just how close we are to achieving true console-quality (close to PS3-quality) gaming on mobile devices. We're not quite there with this chip. We say we're "console-class" today where games are concerned, because the Xbox or the PS3 can still do more things graphically, but Kal-El represents the next step in this direction.

CPU What about the non-gaming, video side of things?

SR Kal-El is capable of decoding very high bit-rate, high-profile video formats that are typically used for content available on Blu-ray Discs. It also supports display resolutions up to 1080p HD.

CPU Can you tell us anything about those Tegra chipsets that are under development but off

in the distance, such as Wayne, Logan, and Stark?

NS There are a lot more cores in these chipsets. We've got a roadmap, with Stark appearing in 2014, three generations out—roughly 70 to 100 times faster than Tegra 2. This tracks with new process technologies, while managing power intelligently. Looking even further down the road, there's Project Denver, announced earlier this year. It will provide us with ARM-based technology, for which we have a license, and affect everything from handhelds to servers and supercomputers.

There are questions about what to do with all this power, but consider what you do with your PC today. All the multitasking, more intelligent apps, better speech recognition, video, pattern matching, and location-aware processing: All the great algorithmic things that you love to have at hand. When your future choice of a mobile device gives you all this, it really will become your main computing device, docked as needed to various keyboard and monitor devices. We don't think desktops or notebooks are going away, but we do believe that handheld mobile devices will become the critical computing device.

CPU So you're saying it's similar to the way various Windows OS iterations have been—that once you have the capability of doing so much more, developers are going to suddenly play catch-up and create whatever content allows users to take advantage of what you're providing?

NS Absolutely. Take our gaming enthusiast GTX 580 chip, which is super-powerful and has amazing graphics quality. That said, it also consumes up to 250 watts vs. sub-1 watt for Tegra 2. As we continue to improve these technologies, we can bring more of these really high-end chip features down into these newer mobile products. ■

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A Peek At What's Brewing In The Laboratory

by Anastasia Poland

The Eyes Have It For Disabled Dialing

For someone who is working with severe physical impairments, even the simple act of dialing a phone may be impossible. Dr. Tzyy-Ping Jung of the University of California, San Diego, along with Dr. Chin-Teng Lin of National Chiao-Tung University in Taiwan, have developed, with their colleagues, a relatively simple system to help the disabled make that call.

The system utilizes a brain-computer interface that reads a user's electrical brain signals via an EEG headband. While wearing the headband, the user views a phone touch pad displayed on a computer screen, with each number in the pad flashing subtly at a different frequency from one another.

"The user's goal was to dial a phone number by looking at the numbers . . . in the correct order," says Jung of the project. "When the user looked at a number, the signals from the visual cortex were picked up by the sensors of the EEG headband, amplified and transmitted through a wireless Bluetooth to a cell phone." After translating the signals into numbers, the phone placed the call. Out of 10 subjects, seven were able to place a call with 100% accuracy.

Although the initial research has been aimed at assisting the disabled, Jung is also excited about the possibility of creating a "cellphone-based fatigue-monitoring system" for drivers, machine operators, and air traffic controllers.

"We plan to continue to optimize the mobile and wireless BCI device to make it a truly wear-and-forget human-machine interface." ■

Yu-Te Wang (University of California, San Diego), is one of the researchers who is working on a brain-computer interface (using an EEG, Bluetooth-enabled phone, and computer) that could allow disabled people to dial a phone by simply thinking the numbers.
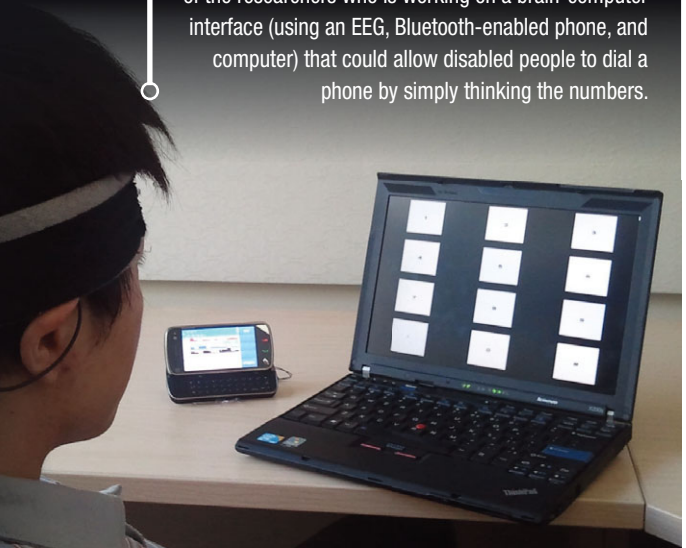
TV's Past Provides Wi-Fi's Future

Despite the seemingly ubiquitous nature of cell phones, laptops, and the like in our lives, there are plenty of places in the United States where people simply have no connectivity. Professor Edward Knightly and his team at Rice University, along with a local nonprofit called Technology for All, have been noodling with this problem since 2004, when they set up a wireless mesh network for an underserved area of roughly 2 square miles in Houston's East End. This past April, the team stepped up the pace from conventional wireless to providing connection in a new way via White Spaces channels (unused frequencies in the broadcast spectrum).

"Our deployment utilizes unused UHF digital TV channels to transmit 'Super Wi-Fi,'" says Knightly. "Despite the name 'ultra-high frequency,' these frequencies are much lower than is used for today's Wi-Fi. Consequently, we can get radically larger transmission ranges and have excellent penetration through trees and walls."

For economically disadvantaged neighborhoods, this reliable access to an Internet connection could be a boon. The group's prototype is compatible with any Wi-Fi client, and the access point is designed to flip between regular Wi-Fi and the White Spaces radio channels in order to provide the most ideal connection.

Knightly says that his team's research differs from others in that it "spans from in-lab ideas all the way to real users." The researchers plan "to jointly use frequencies from 500MHz to 5GHz." Knightly explains that the lower frequencies can bolster feeble signals, while higher frequencies will guarantee hefty bandwidth. "By adaptively selecting the right frequency for the right user," he says, "we can achieve a wireless network unlike anything deployed today." ■
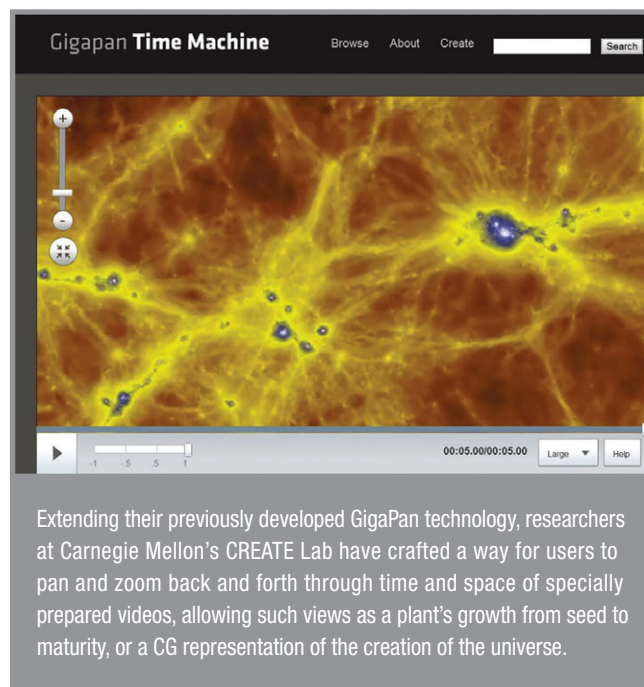
Toggle Through Virtual Time & Space

It's not a phone booth. It's not a DeLorean, either. But scientists at Carnegie Mellon's CREATE (Community Robotics Education & Technology Empowerment) Lab have nonetheless developed an online system dubbed the "GigaPan Time Machine." The system lets users navigate through hi-res time-lapse videos, with simultaneous control over topographical exploration and linear time.

Dr. Illah Nourbakhsh, head of CREATE Lab, explains her group's work. "First, using specialized robotic photographic equipment, the scientist captures repeated, super high-resolution images of the same scene over time and then post-processes the imagery to stitch each set of images into a giant, explorable panorama." These panoramas are then registered together through time, letting viewers swiftly navigate between different scenes.

The team was certainly challenged by the task of stitching together the hi-res photos in time and space; the exactitude of both were needed to pull off realistic visual depth and detail of the videos. The GigaPan team coded the project in HTML5, so, with the video-enabled new releases of Chrome and Safari, the technology is readily available for everyday users.

Nourbakhsh says that the GigaPan Time Machine could be particularly functional in studying "biological processes, such as plant growth and cell division," but she adds that the technology is equally capable of documenting events related to man-made structures, such as progress at a construction site or the "gradual weathering of a bridge or building."

Users can explore the scientists' creations on their site (timemachine.gigapan.org) or can actually create their own "Time Warps" with the GigaPan technology. ∎

Extending their previously developed GigaPan technology, researchers at Carnegie Mellon's CREATE Lab have crafted a way for users to pan and zoom back and forth through time and space of specially prepared videos, allowing such views as a plant's growth from seed to maturity, or a CG representation of the creation of the universe.

TalkMiner Changes The Way You Get An Online Lecture

For those who consume online lectures or webinars, the beauty is in easy access to much-needed info. A frequent downside, however, is having to slog through unnecessary information to get to the nitty-gritty of a talk.

Researchers at FX Palo Alto Laboratory, led by John Adcock, have recently introduced TalkMiner (www.talkminer.com), a free site that addresses exactly this issue. Users input the topic they are looking for
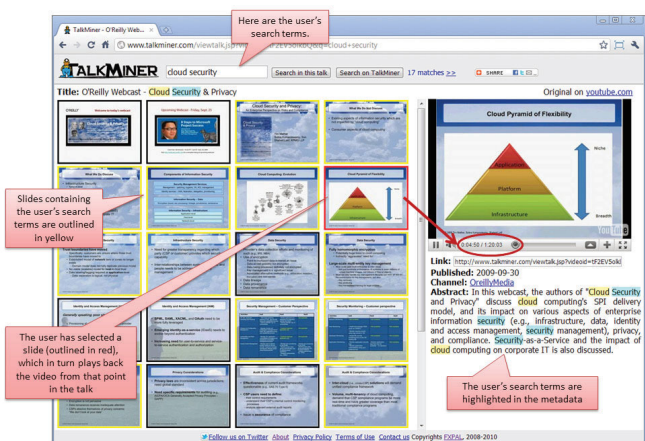
John Adcock and colleagues at FX Palo Alto Laboratory in California are helping out those who utilize online lectures with their new TalkMiner technology. Their site allows users to search for a particular lecture topic and source the time of particular slides in the lecture, delivering the data in easy-to-navigate thumbnails.

in a search field, and the site tracks down appropriate video lectures. Then, explains Adcock, "TalkMiner processes the video and finds the times where slides are displayed. For each slide, we extract the frame from the video and use optical character recognition to recover the text. Then we store the timing information we've extracted about the slides and their text along with a link to the original video."

TalkMiner delivers an overview of the slides via thumbnails, which can also be used to navigate straight to that particular portion of the lecture. Because TalkMiner only processes the videos, users view the lectures on their originating sites, making TalkMiner very lightweight.

Adcock suspects that a host of companies might be interested in TalkMiner's technology. "Enterprises may possess training, e-learning, or other similar video material which they do not desire to publish publicly but still want to take advantage of the value added by TalkMiner indexing," he notes. "We're looking at the whole range of ways to accomplish this, from a standalone cloud service for processing video on demand to complete software systems hosted inside the customer's firewall."

Adcock adds that he and his team are also interested in exploring a speech-recognition component for TalkMiner. ∎

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08.04-07.11
MillionMan LAN - Louisville, KY
www.lanwar.com

08.12.11
Grand Traverse FragFest - Traverse City, MI
www.gtff.us/info/events/planned

08.13.11
LAN Lordz - Wichita, KS
lanlordz.net
Micronet Computer Lan - Fresno, CA
lanparty.micronetcomputer.net/news.php
WV Gamers - Eugene, OR
www.wvgamers.com

08.13-14.11
Pittco's Retro Lan - Pittsburgh, PA
www.pittco.org

08.20.11
NGC's LAN-A-GEDDON - Greenville, TX
www.networkgamingclub.com
Oklahoma Gamers Group - Oklahoma City, OK
www.okgg.org

08.26.11
PAX Prime - Seattle, WA
prime.paxsite.com

08.27.11
LAN OC V9.0 - Ohio City, OH
lanoc.org
Naois Gaming - York, PA
www.naoisgaming.com

09.10.11
LAN Lordz - Wichita, KS
www.lanlordz.net

09.17.11
Intel LANFest Colorado Fall 2011 - Loveland, CO
lanfest.intel.com/?page=event&eventid=1722
NGC's LAN-A-GEDDON - Greenville, TX
www.networkgamingclub.com
Oklahoma Gamers Group - Oklahoma City, OK
www.okgg.org

09.24.11
Naois Gaming - York, PA
www.naoisgaming.com
WV Gamers - Eugene, OR
www.wvgamers.com

10.08.11
LAN Lordz - Wichita, KS
www.lankansas.com

10.14-15.11
Geex Gaming and Electronics Expo - Salt Lake City, UT
geexshow.com

10.15.11
NGC's LAN-A-GEDDON - Greenville, TX
www.networkgamingclub.com
Oklahoma Gamers Group - Oklahoma City, OK
www.okgg.org

10.22.11
WV Gamers - Eugene, OR
www.wvgamers.com

10.29.11
Naois Gaming, York, PA
www.naoisgaming.com

11.12.11
LAN Lordz - Wichita, KS
lanlordz.net

11.19.11
Oklahoma Gamers Group - Oklahoma City, OK
www.okgg.org
WV Gamers - Eugene, OR
www.wvgamers.com

11.26.11
Naois Gaming - York, PA
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Q&A With Robert Cailliau

See The World Wide Web Through The Eyes Of Its Co-Developer

The original logo for the World Wide Web, designed by Belgian programmer Robert Cailliau, shows three overlapping Ws in shades of white and green. Cailliau chose green because he's synesthetic, meaning he combines two senses; in this case, he sees all text characters as having their own colors. For him, Ws are green. With hybrid senses, perhaps it's not surprising that Cailliau landed a job in hybrid computing at CERN, starting in 1974. Sixteen years later, he worked alongside Tim Berners-Lee and was instrumental in bringing the Web into existence.

Q In his notes, Tim Berners-Lee is pretty clear about separating you from the invention of the WWW, although others haven't portrayed you in that way. (CERN calls you "the first Web surfer.") How do you describe your own role and actions in the Web's formation during those early times?

RC I never claimed to have invented the Web, though I do claim that I had similar ideas, as did many other people at the time. The Web took over from all other networked hypertext implementations for two reasons: It worked over the Internet and it is so simple that it scales. (No matter how many servers you add, it does not get slower.) Unfortunately, the Web has to pay a price for being scalable. There is no coherence, and we all know what error 404 means.

Q If you could wave a magic wand and make it so, how would you change today's WWW?

RC I would entirely redo HTML and CSS, and I would also throw out all those incredibly ugly programming languages—JavaScript, PHP, and whatnot. I have a page that uses HTML, CSS, JavaScript, PHP, SQL, SVG, and possibly something else. Why have so many syntaxes that are too far apart to remember and too close together to avoid errors? You talk about "design." Let me tell you, there was no "design" in any of those tools.

Q You have blogged about the trend of tablets and cloud-based data, noting that you want to remain "one of the few weird people who stick to owning a computer" and not be "tethered from a commercial leash like a dog." That's a pretty skeptical view.

RC Skepticism would imply that I do not believe these technologies will work. They do work, and they are desirable. What seriously worries me is that the present implementations are such that the users have no control and no legal framework in which to defend themselves. It is entirely left to commercial companies. We have seen what happens to the citizen when the investment bankers get greedy. Do you think something more positive will happen in the cloud? Not without a worldwide system of controls.

Q Most people don't get to change the world twice (or even once!), but do you have any other projects—present or planned—that might again influence the lives of billions?

RC As you observe, the probability is almost non-existent. And let's not forget that most inventions like the Web are based on a long prehistory and lots of preliminary work. I have no illusion that I can make a big difference.

But I am a member of a group consulting the World Economic Forum on demographics. If humans are going to survive, they will have to seriously reduce the world's population, since individual influence keeps growing and is desired by all who can get it. If nothing is done, then in the next 30 years or so humanity will grow by another 3 billion people. That is more than the entire population of the Earth in 1950! Fortunately, we know that well-educated civilizations with equality of gender and access to family planning have no problems with demographics. Education is crucial to survive the 21st century, and the Web is one of the tools that will help. ■

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